POWER

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Economies in Engineering Terms

WE HAVE REPLACED human effort with mechanical power, and plodding motions of the artisan with the rapid accurate and tireless motion of the machine; we have discovered and developed new materials and methods; we have realized the economies of aggregation; and have developed transportation so that the products of all climes and the resources of all countries are continually interavailable. Materials that a few years ago were bothersome wastes have been put to beneficent uses. Through sanitation, hygiene and research into the causes, prevention and treatment of disease human suffering is being reduced and man's expectancy of longevity increased. By the intelligent application of safety measures and appliances occupational deaths and injuries are being materially reduced.

All of which intelligently applied and righteously distributed ought to go a long way toward reducing the major hazards of the workingman's life, sickness, accident, unemployment, depreciation or loss of savings, impoverished old age or death with dependents unprovided for.

The engineering method of thought and analysis could apportion available man-power to productive demand so that each should have his chance. It could distribute the proceeds so that each could live on a scale commensurate with his contribution to the world's work and retire with a competency.

But what would be the use of an engineer's report to a board of directors who did not understand his terms and whose sympathy with his broad purposes was shrouded with their concern for their narrow interests.

Will there come a time when the economist and publicist with a view to universal well being will be able to speak in the quantitive terms of the engineer and put upon the trestle board a social, financial and industrial model which will place a universal premium on economy and efficiency.

EDITORIALS

St. Lawrence River Development

APPROVAL of the Cornaire Bill to create a water-power authority under which New York State's interest in St. Lawrence River power is to be developed, still leaves many problems for solution before work can be started. After the bill is signed by the Governor there is still the possibility of delay in establishing the power authority. Legal experts do not generally agree that the Governor can appoint a power authority unless its members are confirmed by the State Senate. If senate confirmation is required, appointment of the power authority may have to wait at least a year. There is also the possibility that the whole question may be taken into the courts for determination.

However, the political squabble in New York State has, so far, had little to do with delayed development of the St. Lawrence. First, an agreement must be worked out between the United States and Canada on the entire project. At present negotiations do not appear to be advancing and several recent events have retarded their progress.

After the international question is settled, New York and Ontario must decide when and how the power development is to be made. There is still wide disagreement on the engineering features of the project. Engineers for the United States and New York State recommend a single-stage development, while Canadian engineers want it made in two stages. The engineering board for the New York State water-power commission last year attempted to work out a plan of development that would be satisfactory to both governments, but apparently had little success.

These and other problems must be worked out before work can start on this great water-power. The encouraging part of New York State's interest in the problem is that the governor and legislators are doing their squabbling at a time when it does not interfere with starting work on the project. If they decide how the state's interests are to be handled, by the time work can otherwise be started, something will have been accomplished, even if its has been an unusually prolific source of political controversy.

Flexibility In Plant Design

WHOEVER claimed that engineering is an exact science had very little experience with power plants. Evolution in power plant practice has been so rapid that the brief period between the conception and the completion of some stations has materially altered the operating expectancy. This makes it incumbent to incorporate the utmost flexibility in layout that advantage may be taken of rapidly changing conditions.

Experience has demonstrated that many stations designed to serve as base-load plants have soon ceased to operate as such, owing to changes in load conditions, unforeseen interconnection, or improvements in practice that removed them from the most efficient class. Interconnection has influenced reserve capacity. Also, the advent of high steam pressures and the ever-increasing size of units have upset many preconceived plans for extension.

There now looms another factor that must be taken into account when laying down new plants. This is the rapid extension of natural-gas lines to sections heretofore not considered within the reach of this fuel. Many furnaces must now be designed with a view to burning gas, either alone or as a supplement to other fuel, if and when available. In such cases due consideration must be given to a changeover to other fuel if the natural gas supply be curtailed or diverted to other uses.

The problem of economical plant design becomes increasingly complicated and the need for flexibility is emphasized if expensive alterations are to be avoided.

Will Mercury Go Up?

WITH THE COMPLETION of a year's successful run at Hartford the mercury boiler appears to have passed its development stage. Two twenty-thousand-kilowatt units are now on order and at least two more are under serious consideration. These facts, as they presage more extensive application within the next few years, give rise to the question of

mercury supply and the effect on the market. That mercury is still sold in seventy-six pound flasks may be responsible for an impression of scarcity, unwarranted by the actual conditions.

The bulk of the world's supply of mercury comes from large deposits in Spain and Italy and smaller deposits in some other European countries. The output is controlled by a cartel. Mexico is a potential source but little is known about its reserves. In this country the main sources of supply are California and Nevada but the comparatively small deposits are so scattered as to make quantity production difficult. Reserves in Spain and Italy, however, do not offer this difficulty.

Last year the world's production of mercury amounted to less than 100,000 flasks of which 3,300 were produced in the United States. The greater part was employed in the recovery of gold in South Africa and the remainder was applied to medical and instrument uses. This country imports as much as it produces. Despite the world-wide depression, the price has dropped only from $120 to $100 a flask.

Contrary to lay opinion, the technique of mercury production has undergone improvement during the last few years and the problem in this country is not one of metallurgical process but of scattered supply and lack of definite knowledge of mercury reserves. However, with abundant reserves abroad, and with the European cartel anxious to find new outlets for production and exercising a stabilizing effect, it is most unlikely that wider use of mercury in boilers will be permitted to greatly advance the price, especially as the demands will not be concurrent.

Welding Progress And the A. W. S.

THIS WEEK, in New York, the annual meeting of the American Welding Society opens. As usual, the program is diversified, covering many fields of application and revealing progress in numerous directions.

But even more interesting than the meeting itself is the truly remarkable status of the field it serves. In the midst of business depression the welding industry stands as a beacon of progress. It is hard to restrain enthusiasm as the accomplishments in this field are reviewed and one advance after another in never-ending series is apparent.

No industry is more rich in technical possibilities, in breadth of potential market, in background of research, in co-ordination of fundamental activities.

None is more fortunate in leadership. Free from any incubus of senile conservatism, full of energy and vision and enthusiasm, profoundly appreciative of *facts*, the men behind welding progress today are all young in spirit, although some of the most active leaders are mature in wisdom and years. All see that the first concern is to develop welding technically and practically, render it irresistibly serviceable. They believe that if they do this all things will be added unto them. And the results justify their faith.

Clearly there is nothing "half-baked" about this progress which continues unabated in business depression. It is simply a clean-cut example of what must happen wnen men of vision and capacity see a great opportunity and develop it to the utmost.

The beauty of this picture lies not alone in the financial rewards for those who promote welding. Based fundamentally on service, this development is tremendously helpful to users in industry, and, consequently, to the consumer who pays the ultimate bill.

As the established co-ordinating agency for this whole field of fusion welding, the American Welding Society, is a vital factor in industrial progress.

Driving Home

THE ENGINEER is a thinker and a doer. He expresses himself in tables, blueprints, machines, and *performance*. Words—spoken or written—are not his natural medium.

But engineers, with other professional men, are expected to radiate information and inspiration. Like it or not, they must convey ideas to fellow engineers and to fellow men who are not. Then why not do a job of it?

"I am no writer and no speaker" is the common plea, but a mighty poor one—modesty become a vice. Presented with a knotty problem in his plant, would the engineer throw up his hands because he is "no expert" in this or that? Then why does he expire at the thought of making a speech or bursting into print?

Here are the specifications: He will be a man, not a calculating machine. He will look his listeners in the eye, talk so they can hear him, smile now and then, although some think it a crime. He will write English, not jargon—will see no virtue in purposely painful presentation.

As a practical man he will see that unapplied information is useless and that what is not understood cannot be applied. He will therefore mark "failure" on any story or speech that does not convey thought and impel action—no matter how worthy the content. And he will not be content until he finds a better way to say it.

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POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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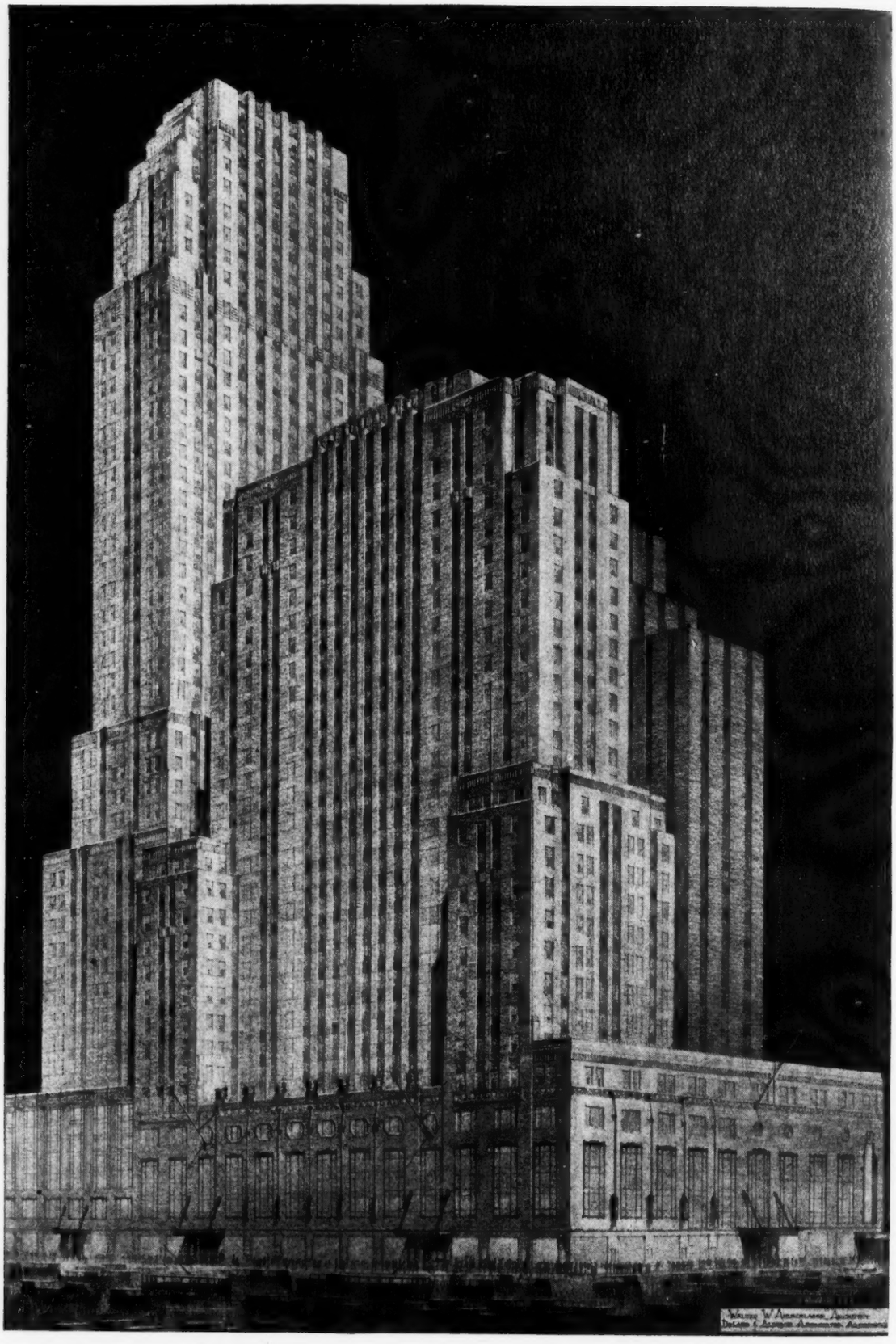

This monumental group, known as the Carew Tower Building, comprises a 50-story office building, a 30-story hotel, two department stores and a 30-story, 1,000-car automatic garage. With a total cubical content of 18,000,000 cu.ft., it rises 575 ft. above the sidewalk and descends 40 ft. below

Servicing the Carew Tower Building of Cincinnati

By RUDY LOWE
Chief Mechanical Engineer
Office of Walter W. Ahlschlager, Inc.

CURRENT is purchased and steam furnished from boiler plant in building operated by the electric company. Mechanical plants are arranged so that each tenant has complete control of his respective equipment and the privilege of purchasing steam, electricity and gas at a group-consumption utility rate

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THE CAREW BUILDING, in Cincinnati, Ohio, completed in January, 1931, comprises a 50-story office building, a 30-story hotel, two department stores, and a 30-story, 1,000-car automatic garage. Some interesting statistics on the structure appears in Table I.

The problem of providing adequate mechanical services to care for the specific necessities of so varied a tenancy was solved by installing the mechanical plant so as to give each of the five main tenants complete control of all equipment required for its use, including the purchase of steam, electricity and gas, at the current utility rate based on the group consumption. Equipment thus delivered to each tenant includes elevators, pumps, ventilating fans, refrigerating machines, hot-water generators, etc.

The individual machine rooms for each of the building units are in the sub-basement, each taking service from a 12x9-ft. utility tunnel built in the form of an "L." This tunnel extends from the boiler room, operated by the Union Gas & Electric Company, of Cincinnati, along the outside wall of the sub-basement, and individual services are brought into the respective machine rooms at convenient locations. This arrangement keeps the sub-basement ceiling clear of large mains, and made possible a minimum of excavation.

The boiler room is at the west end of the building, and extends from the sub-basement to the street level. Four 5,000-sq. ft. Stirling type water-tube boilers have been installed and foundations have been provided for two additional units. Provision has been made to burn coal in underfeed stokers or fire natural gas from the rear of the setting. For the present natural gas is being used, but, should economy dictate, the fuel may readily be changed to coal. Overhead bunkers under the sidewalk have been built to receive this coal and discharge it by gravity to the stoker hoppers. Provision also has been made for pneumatic ash removal. A feature of this system is a vacuum-cleaning attachment for use on boiler tops and floors.

Heating, Ventilating and Air Conditioning

Steam is generated at 125 lb., and the total quantity is metered at the entrance of the supply main to the tunnel. From this main, which extends to the farthest end of the tunnel, a 125-lb. service line is brought into each machine room, and pressure-reducing valve assemblies lower the pressure for the various services. In the case of the office building, the high-pressure main is extended to the twenty-second story, where the pressure is reduced to about 5 lb. for distribution through the heating system and to the high-level hot-water generators. In the case of the hotel, a reducing valve assembly in the sub-basement transforms a portion of the high-pressure steam to intermediate and low pressure for use in the laundry, bake shop and direct and indirect heating systems. A high-pressure main is extended to a sound-proofed room in the fourteenth story, where the high pressure is transformed for use in the heating system.

Schematic diagrams of the steam-distributing systems are shown in Figs. 2, 3 and 4. The total connected heating load for the entire building is equivalent to 365,850 sq. ft. of direct cast-iron radiation. A schedule of the radiation in the various departments is shown in Table II.

In all departments the heating systems are of low-pressure vacuum type and the supply is zoned to regulate according to the exposure. For the office building the heating system is down-feed and up-feed from distribution mains located in the pipe space between the twentieth and twenty-first floors, the returns from this system being gathered together in the pipe spaces above the sixth floor. Fig. 2 shows the method of zoning and the remote-control valves regulating the steam supply to the four branch mains supplying the respective sections of the building.

An up-feed distribution main in the basement supplies the Mabley & Carew department store. A basement main

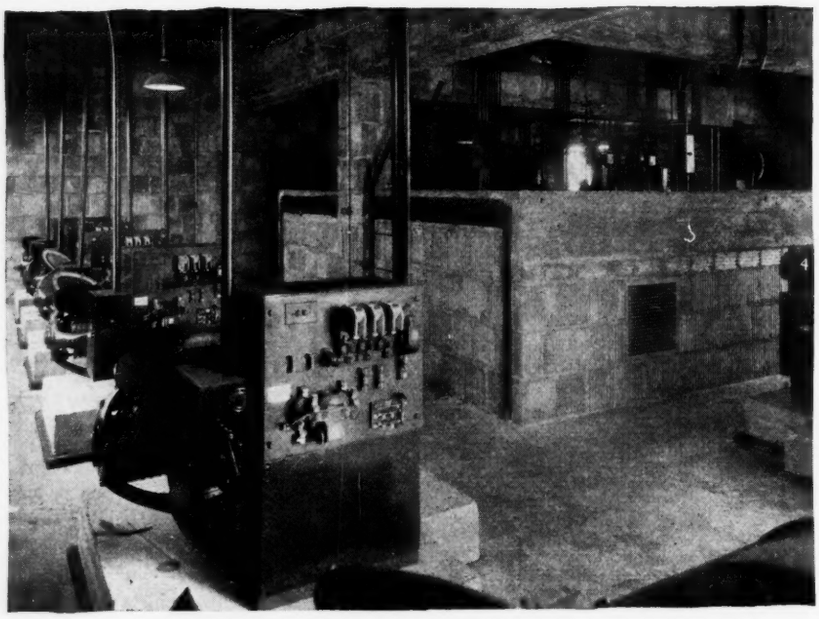

Fig. 1—Unit control panels and motor-generator sets for hotel passenger elevators

serves the public spaces below the fifth floor. The garage, which is supplied only with sufficient radiation to heat the storage spaces to 45 deg., is down-feed from a main in the twenty-fifth story.

The hotel distribution main, in the pipe space between the fourteenth and fifteenth floors, is up-feed to the thirtieth story and down-feed to the fifth, as indicated in Fig. 3. Here also the zoning plan of distribution is in use. The supply to the various services and the independent metering of the direct and indirect heating and hot-water services are shown in Fig. 4.

Radiators in both the hotel and the office building are of the concealed type. This arrangement enables a tenant to enjoy an unobstructed view from his windows and permits of the best furniture arrangement in both office and hotel guest rooms, as there is no projection from the building wall. All radiation units are completely inclosed and recessed in the exterior walls of the building, a 13½ in. curtain wall receiving the required notches, which are plastered on three sides and closed on the front by a No. 16 gage metal panel, with top and bottom grilles for intake and delivery of air, respectively. These radiators are of copper and of the continuous-coil type, with extended surface.

Indirect radiation used in connection with the ventilation is cast iron for units in the sub-basement and of the extended surface type in the upper fan rooms. In all ventilated rooms throughout the building both the direct radiation and air supply are controlled for temperature.

The ventilation system comprises some 50 supply and exhaust fans handling a total of 689,775 cu.ft. of air per minute, the supply and exhaust being balanced within 10,000 cu.ft. in favor of the exhaust. The total power required to handle this air is about 386 motor horsepower, comparatively low for this volume. All the air supplied is either washed or filtered. In the case of the restaurants and public spaces in the hotel portion of the building this air is conditioned for temperature and humidity.

Three carbon-dioxide synchronous-motor-driven refrigerating machines, two rated at 200 tons each and the other at 100 tons, are provided for this service. The air is passed through dehumidifiers in which extended-surface coils cool the spray water that washes the air. Temperature and humidity are under automatic control regulated by thermostats.

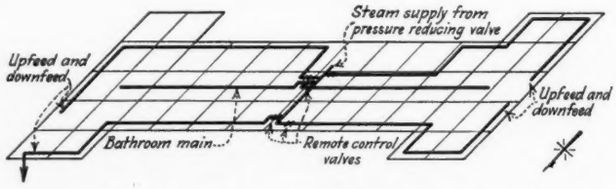

Fig. 3—Isometric of steam zoning plan in hotel

Duties of the complete refrigeration plant are: cooling air to the dining rooms and public spaces in the hotel; cooling all of the refrigerators in the hotel by means of brine circulation; making, hardening and storing ice cream by means of a separate low-temperature brine system; ice making and cooling drinking water in the office building, the Mabley & Carew department store and the hotel.

In the hotel the ice-making and refrigerating plant has a capacity to develop 50 tons of refrigeration per day in two 25-ton synchronous-motor-driven compressors. Six tons of clear, raw-water ice is manufactured in 24 hrs. Storage spaces for both the large cakes and for cubed and crushed ice are adjacent to the tank. During the process of freezing, the water in the ice can is agitated by compressed air, which enables this system to produce clear ice from raw water.

There are seventy refrigerators cooled by brine coils. They have a total cold storage space of approximately 33,000 cu.ft., which is kept at the required temperature by approximately 10,800 lineal feet of brine coils. Cast-iron extended-surface sections are used for this purpose, so arranged that 50 per cent of the cooling units in each box can be defrosted without putting the entire coil out of service.

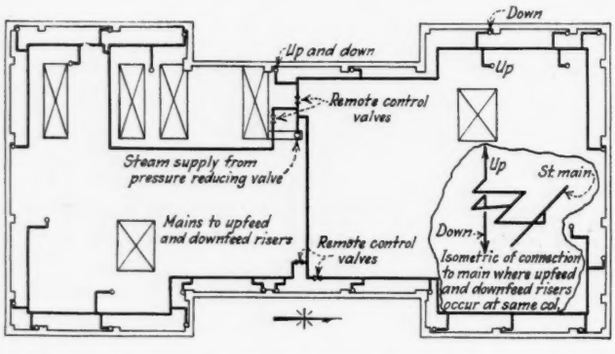

Fig. 2—Steam distribution zoning to office building on twentieth floor

Designed with a view to obtaining the maximum insurance credit for contents and building, the fire protection system earns a minimum rate for both tenants and owner. All shop spaces, storage spaces, kitchens and the entire garage are protected by an extensive sprinkler system having approximately 5,900 sprinkler heads and about eight miles of piping. A 50,000-gal. sprinkler tank located in a penthouse above the garage supplies the entire sprinkler system from that point. The fire pump, which protects both the sprinkler and standpipe system for the whole building, is in a central point in the sub-basement. It has a capacity of 1,000 g.p.m. for the supply of the sprinkler system, and 750 g.p.m. for the standpipe system. It is of the double-end type, operating against a head of 100 lb. and driven by a 200-hp. motor.

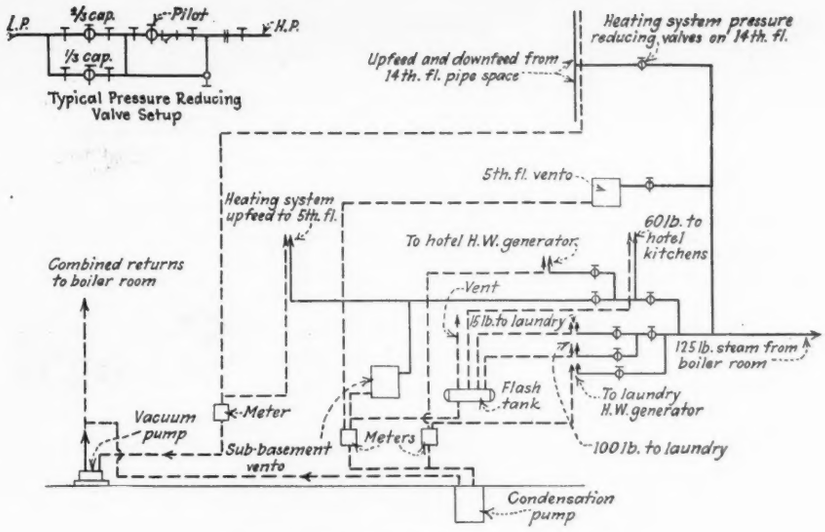

Fig. 4—Diagram of steam supply to hotel

The fire protection system is electrically supervised for water flow, the closing of valves, the level of water in the sprinkler tank, the air pressure in the cushion tank and the electric power for the fire pump. The supervising station, mounted in the firepump room, automatically prints the number, location and time at which any valve is closed or opened, and the location of the water flow in the sprinkler system, as well as giving an audible alarm.

The height of the office building made it necessary to divide the water-supply system into two levels to keep the pressures on the fixtures within satisfactory limits. Individual house tanks serve the respective buildings. The distribution and drainage piping, over 76 miles in length, is made up of galvanized steel for the cold water and drainage, and brass for the hot water. The hot-water generators are of the instantaneous type, which adapt themselves readily wherever an unlimited supply of steam is available. All house pumps are centrifugal multi-stage motor-driven, arranged in duplicate.

Elevators

There are forty-one elevators. Of these, six operate express at 900 feet per minute in the office building section. There are also six 700-ft. per minute locals. The hotel section has nine elevators, six passenger cars traveling at 700 ft. per minute and three service cars traveling at 500 ft. per minute.

Both the office building and the hotel elevators are of the variable-voltage push-button-control type. Landings are made accurately and without vibration, and both shaft and cab doors are automatically opened and closed by individual electric motors.

In the automatic parking garage there are three 500-ft. per minute variable-voltage gearless-drive elevators, each of which has a lifting capacity of 10,000 lb., or two automobiles. Fully loaded, they travel the length of the shaft in about 30 sec. All shaft doors are electrically operated, and the electric parking machine, the doors and other electrical equipment are controlled by the operator from his operating platform, centrally located in the cab.

Owing to the short rise, the Mabley & Carew Department Store is equipped with five 450-ft. per minute worm-geared passenger elevators and one 350-ft. per minute worm-geared freight elevator, which may also be used for passenger service. The Pogue Department Store has two 450-ft. per minute gearless elevators constructed to match its present equipment. Various dumb-

TABLE I—PHYSICAL STATISTICS ON CAREW BUILDING

Land area, sq.ft.	85,347
Cubic contents, cu.ft.	18,000,000
Floor area, sq.ft.	1,400,000
Total height, ft.	615
Above sidewalk, ft.	575
Below sidewalk, ft.	40
Renting area, sq.ft.	1,165,500
Small shops, sq.ft.	37,800
Mabley & Carew Department Store, sq.ft.	162,000
Pogue Department Store, sq.ft.	41,000
Office building rentable area:	
Above sixth floor, sq.ft.	333,000
Below sixth floor, sq.ft.	12,700
Hotel, 712 guest rooms, sq.ft.	237,278
Public spaces, sq.ft.	104,785
Utility spaces, kitchens, laundry, machine rooms, etc., sq.ft.	102,226

TABLE II—SCHEDULE OF RADIATION

Direct radiation, entire building, 3,868 heating units, sq.ft.	89,850
Indirect radiation, entire building, sq.ft.	131,000
Hot water, entire building, sq.ft.	116,000
Kitchens and laundry of hotel, sq.ft.	29,000

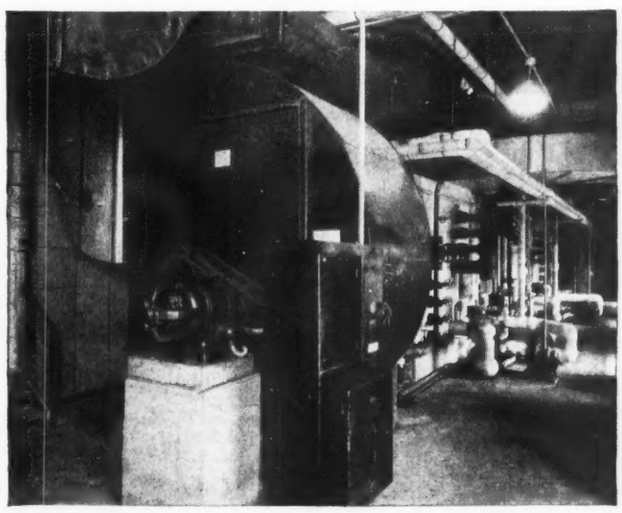

Fig. 5—Typical ventilating and air-conditioning unit

waiters, sidewalk elevators, lifts, a 12.5-ton hydraulic elevator and a shuttle elevator make up the balance of the equipment.

Electrical Equipment

The electrical load, consisting of a total connected lighting load of 3,500 kw, and a motor load of 4,600 hp., is connected to the Union Gas & Electric Company's 13,200-volt high-tension feeders through two transformer vaults in the basement Each vault contains four 450-kva., 3-phase, 60 cycle delta-star-connected transformers fed through feeders from four substations. The low-tension sides of the transformers are interconnected and also are

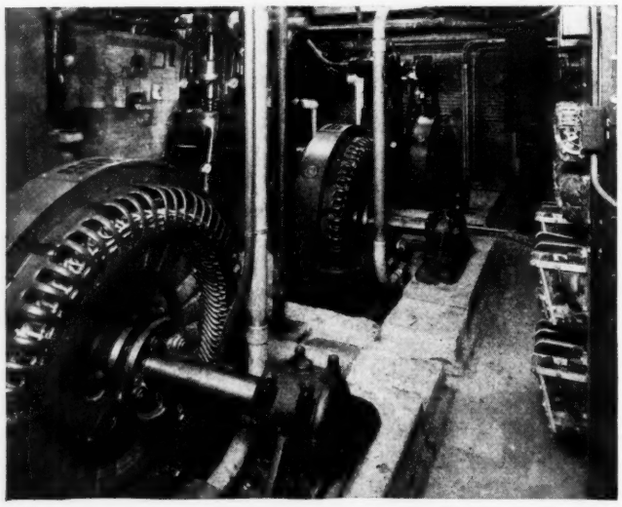

Fig. 6—Synchronous-motor-driven CO^2 compressors in hotel plant

connected to the regular network system of the electric company.

Current for lighting is distributed through the building by 208 120-volt, 4-wire, 3-phase feeders. Smaller power loads, such as kitchens, etc., are supplied with 208-volt, 3-phase current. All current for feeders leaving the switchboards for the larger motor centers, such as elevator, fan and air-conditioning machine rooms, is transformed from 208 volts to 440 volts by 3-phase auto-transformers. By this arrangement a considerable saving of copper is effected.

In a project of such size as Carew Tower, with its many kinds and varied uses of motors, the power factor is lowered considerably. This is corrected by the use of synchronous motors with slightly leading power factors for the heavier machinery.

Floodlighting System

Current for the floodlighting system, which illuminates the upper stories of the office building, is supplied by the regular lighting feeders, thus dispensing with the necessity of using separate feeders. This is made possible by the fact that the floodlights are in use only during the period when the tenant lighting load is decreased to a point where the current in the regular lighting feeders can be diverted to this use.

The office of the building is kept in direct communication with all branches of service, such as engineers, carpenters, plumbers, and elevator starters, as well as machine room and servants' quarters by means of an interior intercommunicating, selective-ringing, selective-talking house telephone system.

The building was designed by Walter W. Ahlschlager, architect, of Chicago and New York, with Delano & Aldrich, architects, of New York associating. The steel structure and foundations was designed by Lieberman & Hein, engineers, of Chicago. The buildings were erected complete by Starrett Brothers, Inc., of Chicago and New York, and are the property of the Starrett Ohio Corporation of Cincinnati.

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Water Walls Add 50% to Boiler Capacity

SUDDEN CHANGES in plan such as are prevalent in the automotive industry, the sudden transfer of departments to other works, and the adding of additional requirements after preliminary estimates have been made, frequently call for equally rapid changes in the services from the power plant. A case in point is a recent addition to the boiler plant of the Murray Corporation of America, at Detroit.

In 1925 the boiler plant contained two 7,500-sq.ft. stoker-fired boilers and had just been enlarged by the addition of a 10,000-sq.ft. boiler equipped to burn pulverized coal. Subsequent plans calling for new building provided with a large number of spray booths, requiring frequent air changes and therefore vast quantities of steam for heating, again demanded more boiler capacity.

Estimates including the new building indicated a total maximum hourly demand for 170,000 lb. of steam. On this basis another 10,000-sq.ft. boiler of the four-drum bent-tube type was purchased and delivered, but before it could be installed more spray booths and ovens were added, increasing the steam demand by at least 30,000 lb. and bringing the total up to approximately 200,000 lb. per hour.

Boiler Capacity Raised Without Increasing Size

As the new boiler was to occupy the remaining available space in the boiler house and as there was no room to extend the building, the logical course was to increase the capacity of the lately acquired boiler. At nominal rating this boiler would deliver 30,000 lb. of steam per hour. At 200 per cent rating its capacity would double, and as the latter output already had been taken into account in the early estimates, an additional 30,000 lb. of steam had to be provided.

It was therefore decided to add sufficient water surface on the side and rear walls of the furnace to give the desired increment in capacity. The drums had to be drilled for the numerous 4-in. riser and downtake tubes and for 35 additional $3\frac{1}{2}$-in. circulating tubes between the upper middle and rear drums. For example, the middle drum required drilling for 14 riser tubes and 35 circulating tubes, the rear drum for 35 circulating tubes, and the mud drum for 18 downtake tubes and for 29 rear

wall tubes. The arrangement of these tubes is indicated in the illustration.

On each side wall are thirty-one 4-in. fin-type tubes spaced on 7-in. centers. These tubes, at both ends, curve through the wall to headers exterior to the setting. Four downcomers from the mud drum lead to each lower side-wall header. Circulation is upward through the side-wall tubes to the upper headers, from each of which seven 4-in. uptakes deliver into the upper middle drum.

Other surface consists of twenty-nine 4-in. fin-tye rear-wall tubes and fourteen 4-in. straight tubes in the floor screen, which are spaced on 14-in. centers and terminate in external headers front and rear. Ten 4-in. downtakes from the mud drum connect into the front header. The circulation continues through the floor screen tubes to the rear header, and then up through the rear-wall tubes, which enter the mud drum and by means of curved loose-fit nipples direct the flow positively into boiler tubes leading to the front boiler drum.

Total Surface 1,139 Square Feet

In these various tubes there is a total of 1,139 sq.ft. of active surface, made up as follows: side walls, 720 sq.ft.; rear wall, 224 sq.ft.; floor screen, 195 sq.ft. That this added surface has been effective is indicated by the fact that in operation over 100,000 lb. of steam per hour has been generated by this boiler.

But the foregoing is only part of the story. Originally it had been the intention to burn sawdust and hog fuel. A subsequent decision to transfer wood-working operations to a new plant at Memphis, nearer the timber supply, eliminated the wood refuse, so recourse to another fuel became necessary.

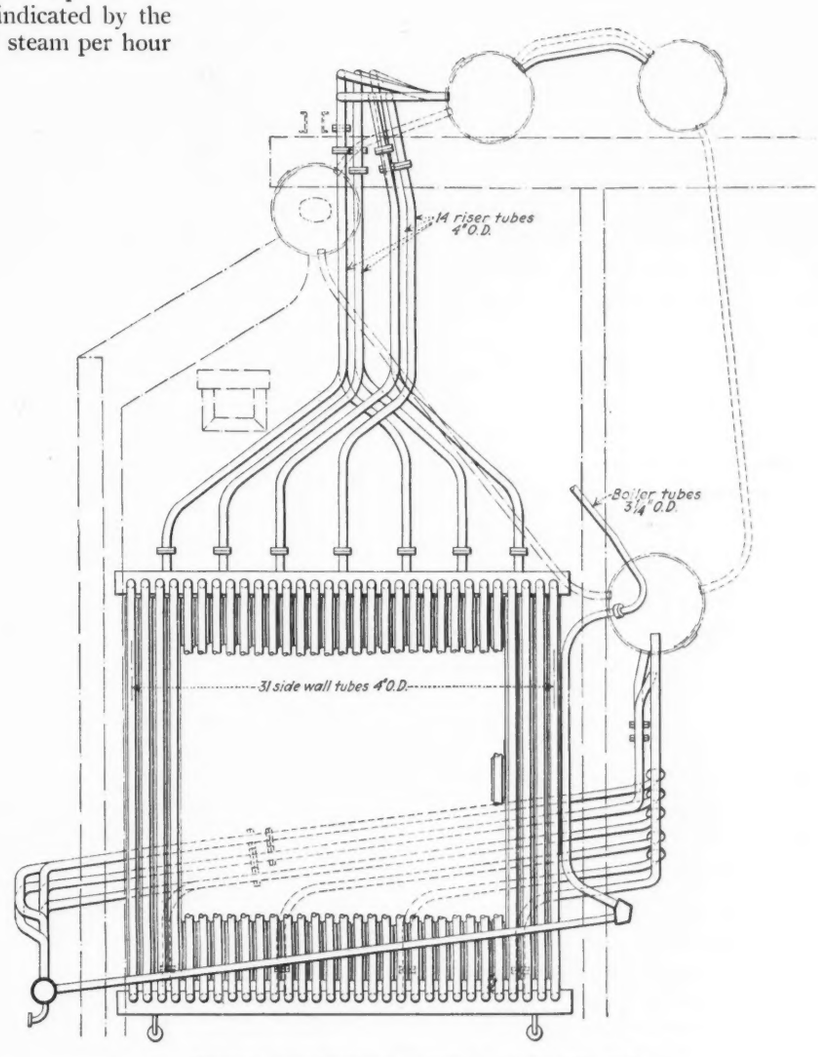
Enlarged capacity requirements pointed to the use of pulverized coal and the installation of a twin air heater of the vertical plate type having a total of 9,108 sq.ft. of plate surface. Motor-driven forced- and induced-draft fans of 45,000 and 95,000 c.f.m. capacity, respectively, were located on a platform above the air heater.

For the previous 10,000-sq.ft. boiler coal had been pulverized by two 4,000-lb.-per-hour impact mills. Two new 6,000-lb. mills of the same type were ordered, and for flexibility it was decided to equip each boiler with a mill of each size, the location being changed to the basement floor. Light loads would call for operation of the 4,000-lb. mill, medium loads would require the larger mill, and upon heavy demands for steam both mills would be operated.

One burner per mill, or two horizontal burners per boiler, serve each unit. In the later boiler the furnace volume above the floor screen is 7,300 cu.ft. Burner locations, 3 ft. each side of the center line of the furnace and 5 ft. up from the boiler-room floor, are convenient for control and observation. Air preheated to 370 to 425 deg. F., depending upon the rate of operation, is provided by ducts passing from the air heater along both sides of the setting and across the front, with connecting ducts dropping vertically downward to the casing of each pulverized-coal burner.

From the overhead storage bunker the coal is weighed in a one-ton traveling larry and discharged into a 3-ton hopper over the coal feeder to each mill. Ashes are collected in a hopper bottom to the furnace. Through three hydraulically operated gates the ashes are discharged into a scraper conveyor, which rises to a point giving direct delivery into a truck for disposal. To quench the ash the horizontal length of the conveyor trough is maintained full of water.

The project was designed and the construction supervised under the direction of Albert Kahn, Inc., engineers and architects of Detroit, Mich.



Furnace arrangement showing water walls and their connections to boiler drums

BUYING COAL FOR PROFIT—III

Plants That Saved by Market Studies

Here is the proof of the pudding. Case studies of seven plants illustrate the money value of coal-market studies that include analysis of equipment capabilities. One plant saved $20,000 annually in coal bills.

By G. B. GOULD

President, Fuel Engineering Co. of New York

THE IMPORTANCE, from a practical business standpoint, of relating steam-plant performance to attainable coal-market values strikes home when the actual experience of a number of plants is reviewed. For this purpose five plants in particular have been chosen for their wide diversity of equipment, but all subject to the same coal market influence, and the coal costs per thousand pounds of steam for all of them have been reduced to a comparable basis.

For diversity of equipment these plants cover every type of coal-burning equipment—underfeed, overfeed and chain-grate stokers, pulverized coal, and vertical-jet combustion of crushed coal in suspension. In heat-recovery equipment they include both fire-tube and water-tube boilers, the latter in various combinations with economizers, air preheaters and water walls.

These five plants made an average reduction in unit fuel costs of 19 per cent by bringing into proper relation their coal selection, plant operation and the equipment limitations. Two of them made a further reduction of 21 per cent by modernization which made possible both higher efficiency and a lower original cost of energy in the coal market.

In the first article of this series (April 7) it was shown how widely the basic cost of energy varies according to the physical characteristics of coal, reflecting the selective pressure of demand for those characteristics which is presumably caused by the engineering requirements imposed upon the selection of coal by plant design and operating requirements.

Earlier Comparison Reviewed

In the second article (April 14) these differences in the basic cost of energy in the coal market were related to the resulting variations in the coal cost of steam. Applied to a hypothetical plant, these figures showed that the range of original energy cost was sufficient to cause as wide a difference in the unit cost of steam as the whole range of boiler and furnace efficiency from the indifferently operated, practically obsolete, plant to the best operated and most modern plant.

In constructing that scale of steam costs three efficiency points, 64, 72 and 86 per cent, were arbitrarily chosen, and these were applied to the two groups of coals which yielded the highest and lowest energy values per dollar, based on prices quoted during the summer of 1930. In actual every-day practice, however, one must deal with efficiency values as he finds them, with coal values at points between the extremes, and with a variety of coal limitations from the least to the most severe. It was necessary to start with certain generalizations, in order to avoid the interplay of these several factors on the cost of steam as they are found in actual practice, and so make possible the isolation of each factor.

History of Five Plants

The way these factors effect actual plants is even more interesting, and the case histories for a number of plants have been selected from our files for purpose of illustration. Continuous records of performance are available in all of these cases, so that the figures are based on average performance for periods varying from two months to a year or more.

The cost figures have been modified, where necessary, to the basis of coal prices applying to the particular coals in each case during the summer of 1930. Thus the figures for the several plants are comparable both to each other and to the scale of values used for the hypothetical scale in the preceding article; and any distortion due to changes in the general level of coal prices is avoided.

The first five cases to be discussed cover plants at widely separated points in the Middle Atlantic and New England States, and the figures for these plants have been modified to conform to what they would have been at a point where the lowest freight rate for bituminous coal was $2.76 a net ton. Otherwise they would not be comparable.

What happened to the coal cost of steam, in each of the five cases, after the elements which affected the steam costs were reduced to a comparable basis, is shown by the accompanying chart. This chart also includes the typical scale, repeated from the former article, for comparison.

In discussing these cases it will be necessary to refer to coal-market values, which can be most conveniently identified according to the five groups into which they were divided, beginning with Class A, which included those coals which yielded the most energy for a dollar.

Reducing the differences of average B.t.u. value and price to an equivalent of cents per ton of coal, Class A included those coals which came within 20 cents of the

best individual value. Class B was composed of those falling between 20 and 40c. below the best value; Class C, those between 40 and 60c.; Class D, those between 60 and 80c.; and Class E, those below 80c. It will be remembered that these amounts represent in cents per ton the premium which the market has placed on such physical characteristics as fusing point, volatile and grindability.

Hands Tied in Plant No. 1

Plant No. 1 was found to be operating with a typical Class A coal. That is, the basic cost of energy in the form of coal was practically as low as possible. In fact this plant's coal buying had been skillfully conducted with that objective, but without co-ordinating the accompanying consequences in plant performance either with these values or with other market possibilities. The combined boiler and furnace efficiency was averaging 60 per cent, it was found.

This fact was news of a disturbing nature to the management, which was rather proud of a steam plant which had been "modernized" only a few years before. At that time there were installed, among other things, new underfeed stokers of a make which was then, and still is, highly regarded, as it should be.

It would be easy, in a case like this, to jump to the conclusion that lower steam costs were solely a matter of better operation. Raising the efficiency to 70 per cent or better would have reduced the coal cost of steam from 23.3c. to about 20.0c. In this particular plant that would have meant a yearly saving of some $12,000.

But the real obstacle to lower coal costs was less obvious than that, and more deep-seated. The plant had been designed with a thoroughly approved type of stoker, but with a grate area too small for the rate at which steam had to be generated, *if* at the same time it was to use the typical Class A coals, with their low basic cost of energy, because along with those values, it may be remembered, goes low fusing point. The coal in use at the time had a fusing point of about 2,300 degrees.

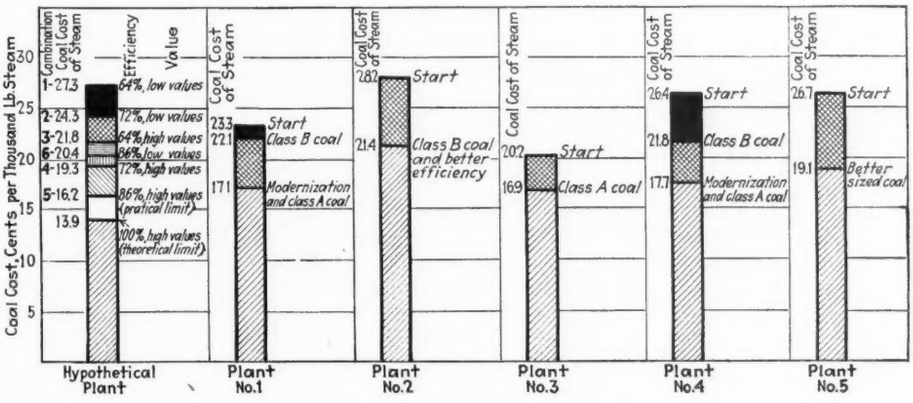
To raise the efficiency would have required a substantially higher CO_2, which, in turn, would have raised the furnace temperature to a point that would have all but shut the plant down with clinker trouble, to say nothing of increased repair costs. To operate at a good efficiency without clinker trouble, this plant required a coal with fusing point of 2,700 deg. Such coals are scarce in the three best-value groups (A, B or C). Only 3 out of 53 coals in these groups, in our earlier analysis of coal market values would qualify. The typical Class D coals, in which group not quite half of the coals would meet this fusing point limitation, would have almost exactly offset the gain due to higher efficiency by the higher original cost of energy.

That alternative might have been preferred, but it is unlikely that it would have been hit upon, unless steam generation had been continuously directed with more detailed information on the characteristics of individual coals than is usually available. There was only about a 50-50 chance of hitting on a coal in this case that would even balance the existing method of operating at a depressed efficiency. As can be seen by comparing point 2 on the hypothetical scale with the vertical bar for Plant 1, the choice of a coal from Class E, in which group 2,700 deg. fusing point is common, would have resulted in a higher coal cost.

Saves $4,000 by Coal Selection

Obviously the only chance for further economy in this plant, short of a major change in equipment, was by discriminating coal selection of some one of the very few coals, which would meet the higher fusing point requirements, to be found in the higher value classes (A, B or C). And that is what was done. The cost of coal per ton was increased about 60c., a part of which was compensated for by a higher heat value. And with the higher efficiency, which now became possible, the coal cost per thousand pounds of steam was reduced to 22.1c., which in this case meant a saving of about $4,000 a year.

This was worth while, of course, but far short of the $12,000 which might have been saved if the plant had been designed in the first place with a better understanding of the economic relation between plant limitations and the coal-market values. This oversight and the resulting limitation on coal selection placed what amounts to a permanent penalty on this plant of $8,000 a year in today's coal market. This amount capitalized at 10 per cent would just about equal the original cost of the plant.



"Before and after" costs in five plants. Based on actual prices paid for coal in the summer of 1930, and on equalized freight rates

Another $20,000 From Modernization

One of the important advantages of this kind of an analysis of steam-generating economy, properly related to coal-market values, is found in the fact that it not only discloses the $4,000 that could be saved, but it puts a dollar value on the limitations yet to be overcome. In the foregoing case, about a year later, additional steam requirements made imperative some alteration of the steam plant. In view of the fact just given, it was obviously worth while to completely modernize the plant, rather than to extend a plant already severely limited.

This was done, and today's coal cost per thousand pounds of steam is down to 17.1c., very close to the hypothetical limit set in the scale at the left, for this plant is back to Class A values at an efficiency above 80%. Not only was the $8,000 a year penalty removed, but a total of $20,000 was cut off of the previously improved cost. The plant still has some coal-buying limitation, as every plant must have until we reach perfection; but it is one that carries with it no serious penalty marketwise, with adequate methods of discrimination among the available coals.

Plant 2 Cuts Steam Cost 6.8c.

Plant 2 presents a distinct contrast to Plant 1. From an equipment standpoint it could be considered obsolete. For years a coal which yielded a little better than average Class E value (representing the highest price for energy) had been bought on the theory that all these desirable characteristics must be worth paying for. Meanwhile the operating staff struggled to improve efficiency without much success.

On analysis, it appeared that this plant had no serious coal-buying limitations, and the equipment naturally lent itself to the use of the type of coals found mostly in Classes A and B. It had a grate area relatively twice as large as that in Plant 1. Due to the fact that the expensive type of coal was not fitted to it, the efficiency hovered around 60 per cent and the coal cost per thousand pounds of steam stood on our comparative scale at 28.2c. The limit of efficiency for this plant, with any kind of coal, is undoubtedly about 67 or 68 per cent. The coal was changed to one in the B group, which not only yielded much better values, but facilitated operation, so that the average efficiency rose to 67 per cent. The coal cost of steam dropped to 21.4c. Any substantial improvement beyond this will have to wait for a wholly new plant.

Yearly Saving $20,000 in Plant 3

It is interesting, however, to note what a short distance there is between the improved cost in Plant 2 and the original cost in Plant 3, which is a really modern steam plant with every possible device for heat recovery and capable of very high combined efficiency. At the time the analysis was made this plant had been operating for a considerable period with a Class D coal recommended by the makers of the combustion equipment and the designer of the plant.

This was not by any means the least economical choice, but considering this plant's freedom from coal-buying limitations there was still room for a substantial reduction in costs by taking full advantage of the market possibilities. When this was done and a change made to the most desirable coals in the A group of values the coal cost of steam dropped immediately to 16.9c., giving an annual saving of nearly $20,000 under normal load requirements.

Steam Cost Saving 8.7c. in Plant 4

Plant 4 was limited somewhat as No. 1, but not quite so severely. No doubt as a result of repeated disappointment in trying to find a suitable coal, coal buying in this plant had settled down to a typical Class E coal, while maintaining a good operating efficiency. More extensive knowledge of coal-market values in detail could have made possible the choice of a suitable coal yielding a value in the Class C group, which without sacrificing anything in efficiency, would have reduced the cost to 22.8c., with a chance to reducing it another cent to 21.8c. by still more discriminating choice among the Class B values.

This would have brought the coal cost down about half way to the present practical limit of economy for any plant, but here another factor weighed heavily. The combustion equipment was old, and repairs were running very high. The boilers had many years of useful life in them.

In this case, good judgment dictated the modernization of the combustion equipment only, at a fraction of what the cost would have been to install completely new equipment. High efficiency was thus secured, along with great freedom in coal selection, resulting in a coal cost, on this camparative scale, of 17.7c., which it will be noticed is closely comparable to the results in Plants 1 and 3, both of which were completely modernized.

In this connection, it is interesting to observe how this kind of a comparison between plants, corrected for differences in freight rates due to different locations, will disclose the relative economic ranking of a plant, when the actual figures would conceal it. The final improved costs in Plants 3 and 4, it will be seen, are quite close on this comparable basis. Due to the fact that Plant 4 has to pay much more for transportation of coal, its actual cost per thousand pounds of steam is 27.4c., as compared with an actual cost for Plant 3 of 18.1c., most of the difference being caused by the unchangeable factor of location.

Better Sizing for Plant 5

An entirely different set of conditions was found in Plant 5. It was burning No. 3 buckwheat anthracite, and very well equipped for the purpose. The value being secured in the coal market, as far as price and energy value were concerned, could not be improved upon. Analysis of the situation, however, revealed exceptionally low efficiency for the equipment, and the related fact that the coal contained an excessive proportion of undersize. A better sized No. 3 buckwheat was selected, and much improved efficiency became possible, with the result that the coal cost per thousand pounds of steam, on our comparative scale, was reduced from 26.7c. to 19.1c. Here, the sizing of the coal was not a matter of commercial grades, and consequently had no direct relation to the price of the coal, but imperfect sizing within its commercial grade had not been related to the resulting effect on plant performance.

Old Plant Outstrips Its Modern Neighbor

Forgetting the special scale constructed for comparative purposes for a moment, it is interesting to see how coal limitations reflected in the *size* of coal it is found necessary to buy for satisfactory operating conditions can nullify the supposed advantages of the modern plant. To illustrate this, here are the figures for two plants in the Middle West using Illinois coal. I shall designate them as No. 6 and No. 7.

Plant 6 is fairly old. There is nothing spectacular about it from an engineering standpoint, but it is well designed for the service it has to perform, and well operated, averaging close to 70 per cent efficiency. It uses Illinois screenings, of about as good quality as can be bought, and at a favorable price. The resulting coal cost per thousand pounds of steam is 16.8c.

In the same section, taking the same freight rate on coal, is Plant 7, less than two years old, operating at an average of 78 per cent efficiency, and the recipient of

much favorable publicity in engineering circles. Due to improper relationship, however, between furnace design, grate area and combustion rates, this plant has found it necessary to burn a sized coal, at a substantially higher price. In spite of its much higher efficiency, the coal cost of Plant 7 is 17.4c. per thousand pounds of steam; or slightly higher than that found in Plant No. 6.

In another plant, also in the Middle West, using Illinois coal, a similar difference exists between two batteries of boilers in the same boiler room. One requires a sized coal which results in a coal cost of 26c., while the other battery operates on screenings, at approximately the same efficiency and at a cost of 22c. In this case, however, the low-cost battery is the more recent; the higher cost on the other battery is a heritage of the past.

These seven plants cover all kinds of combustion equipment: chain grates, overfeed and underfeed stokers, pulverized coal and a vertical-jet furnace burning crushed coal in suspension. Equipment of Plants 2, 4, 5 and 6, includes neither economizer nor air preheater, No. 1 includes economizer only after modernization, No. 3 is equipped with economizer and air preheater, and No. 7 with air preheater but no economizer.

If one compares the lower cost points shown for each of the five plants, when reduced to a comparable basis, it is clear that a wide variety of equipment in itself is not as large a factor in the fuel cost of steam as operating methods, coal-market values and the proper adaptation of coal selection to the particular situation.

It can perhaps be seen from these actual case histories that the seemingly hypothetical case presented earlier is in fairly close agreement with actual conditions, and that the relative weight of the three factors in steam economy—equipment, operation and coal selection—should be determined individually and as they affect each other if maximum economy is to be reached and maintained.

Correlating Attainable Values and Plant Performance

The importance of coal values themselves, and their relation to plant design and operation from an economic standpoint, is seldom given the serious attention it deserves. This is largely because of the difficulty of making *economic* comparisons, which require a measure of the attainable values in the coal market at a given time, properly related to purely engineering measures of plant performance. This difficulty is probably the basic cause of needlessly high costs in a large number of industrial plants, and of many unprofitable investments in plant equipment.

[Next week the concluding article in Mr. Gould's series will show what a great economic penalty may be incurred by equipment selection that imposes permanent coal-buying limitations.—Editor.]

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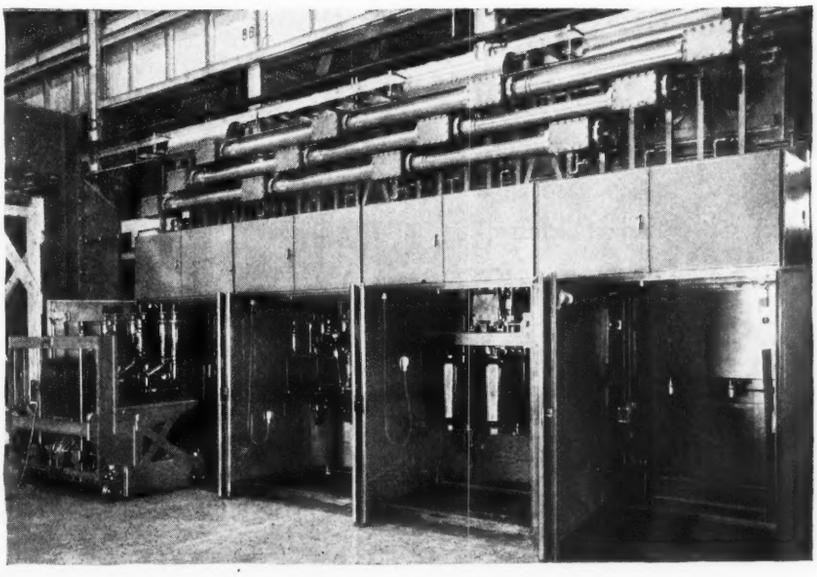
Metal Enclosed Oil-Filled Switchgear



A FOUR-UNIT section of indoor metal enclosed vertical lift type oil-filled switchgear built for the Joy Road substation, City of Detroit, by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This section is connected to a similar section with an ultimate capacity of ten units.

At the extreme left is illustrated the method of removing a breaker from its housing. In the housing to the right the breaker has been lowered ready for test or removal, and in the next housing the breaker is shown in the normal position. The breaker unit has been removed from the housing at the extreme right to show the compartment.

The oil circuit breakers are Westinghouse type O-22, 23 kv., with an interrupting rating of one-half million kilovolt-amperes.

A 3,000-Hp. Diesel For Freeport, N.Y. Municipal Plant

By L. H. MORRISON

Associate Editor of POWER

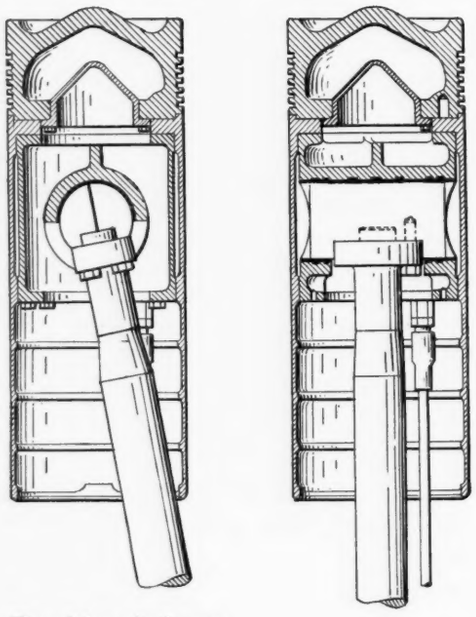


Fig. 1—The piston pin is supported over its entire length

The Freeport, L. I., municipal power plant at present has 5,665 hp. of air-injection diesels. Increase in load required the purchase of a 3,000-hp. unit. This Busch-Sulzer Hesselman system engine requires no more space than does one of the 1,100-hp. units now in the plant.

SIGNIFICANT as showing the trend toward general adoption of the airless-injection diesel was the purchase of a 3,000-hp., 10-cylinder, two-stroke-cycle engine of that type by the Freeport, L. I., municipal light plant. The manufacturer of this engine, Busch-Sulzer Brothers Diesel Engine Company, has been building air-injection engines since 1898 and has recently obtained a license to build the German A.E.G.-Hesselman airless, or solid, injection diesel.

As will be seen from Figs. 2 and 3, the Freeport engine is made up of modified *A* frames upon which are placed the cylinder blocks, each containing five cylinder liners. Tension rods reach from the lower surface of the subbase to the top of the cylinder block, to take the pressure reaction. While the unit was not designed with minimum weight in view, the 10-cylinder engine weighs approximately 100 lb. per brake-horsepower.

Each cylinder is 19½ in. bore x 27-in. stroke, and delivers 330 hp., of which 33 hp. is consumed per cylinder in operating the motor-driven scavenging blower.

Scavenging is through two sets of ports, as in other Busch-Sulzer designs, with the upper tier provided with light strip-type automatic air valves to prevent passage of cylinder gas into the air manifold, which could otherwise occur as soon as the piston uncovered the upper row of ports. The use of two port tiers enables the cylinder to be completely charged with air after the exhaust ports have been closed.

The cylinder liner sets upon the cylinder block, while the head rests on the liner flange. This brings the bearing points practically vertical, eliminating the usual bending movement at the flange. The head in the large crosshead-type engines is secured by a steel collar which completely incircles it. This is not needed in the smaller trunk-piston type, in which the head is a one-piece conical casting, as shown in Fig. 2.

Novel Cylinder Construction

Attention is called to the piston construction, Fig. 1. The crown is a steel casting provided with an internal oil-cooling cavity and held to the skirt by studs. The skirt is a single tube, without the bosses customarily employed to support the piston pin ends. The piston pin is attached to the flange end of the connecting rod and rests in an internal housing. The design gives a bearing surface double that possible with the standard design of piston pin. As there are no holes through the piston skirt, distortion should be absent and leakage of lubricating oil at the pin ends avoided.

The lubricating oil that passes up through telescopic tubes to cool the piston crown does not enter the crankcase sump, but passes through piping to the outside oil

sump and is circulated by an individual pump. However, leakage at the telescopic points will cause no such ill effects as water may, since the oil is the same grade as that employed for bearing lubrication.

In view of the current discussions on crankcase explosions, the sludge compartment of this engine is of importance. As will be seen in Fig. 2, between the crankcase and the cylinder liner is a space in the cylinder block open to the atmosphere. The upper piston rings wipe any excess oil on the upper liner into this sludge chamber, and similar rings at the lower edge of the chamber wipe excess oil from the piston skirt.

Fuel Injection System

The fuel-injection system and combustion chamber shape are of the A.E.G.-Hesselman type. There is a separate fuel pump for each cylinder, all pumps being combined in a common housing, with a single drive. The fuel lead is constant for all loads; the quantity is regulated by the governor control of the point of opening of the spill valve. The arrangement is such that the engine may be made directly reversible by the addition of astern cams and a few simple parts, the starting, stopping, reversing and fuel-control being performed by means of a single handwheel.

The scavenging air ports are shaped to direct the air in spiral currents, so that as the piston approaches the cylinder head the entire air mass has a circular flow of a definite velocity. The spray valve is provided with several orifices to inject the five streams of oil into the moving air mass.

A second 3,000-hp. unit has been purchased by the Public Service Company of Colorado for its Sterling plant.

A six-cylinder, 4,000-hp. Hesselman engine has been sold to the Tucson Gas & Electric Company, Tucson, Ariz. This utility has in service two similar engines with air injection.

This six-cylinder unit is of the crosshead type, of the general frame design that has been employed on the air-injection diesels. The injection-air compressor, however, is eliminated, which shortens the engine's length and increases the resistance of the shaft against torsional vibration, as the shaft is shorter.

Originally the air-injection diesels were provided with double-acting pumps, driven from the crankshaft, to supply the scavenging air. This design was abandoned in favor of a motor-driven centrifugal blower, and the crosshead-type Hesselman engines have this latter scavenging-air source.

The advantage of the airless-injection system is the somewhat better fuel consumption, due to the elimination of the lost compressor work, and the slightly lower manufacturing cost.

Airless injection engines of cylinder sizes which permit reasonably large spray orifices are able to burn as heavy an oil as an air-injection engine.

The manufacturers expect that the large diesel will play a more important part in industry than it has in the past, even though marine orders are almost an unknown quantity in this country and adoption of large engines for stationary use has been slow.

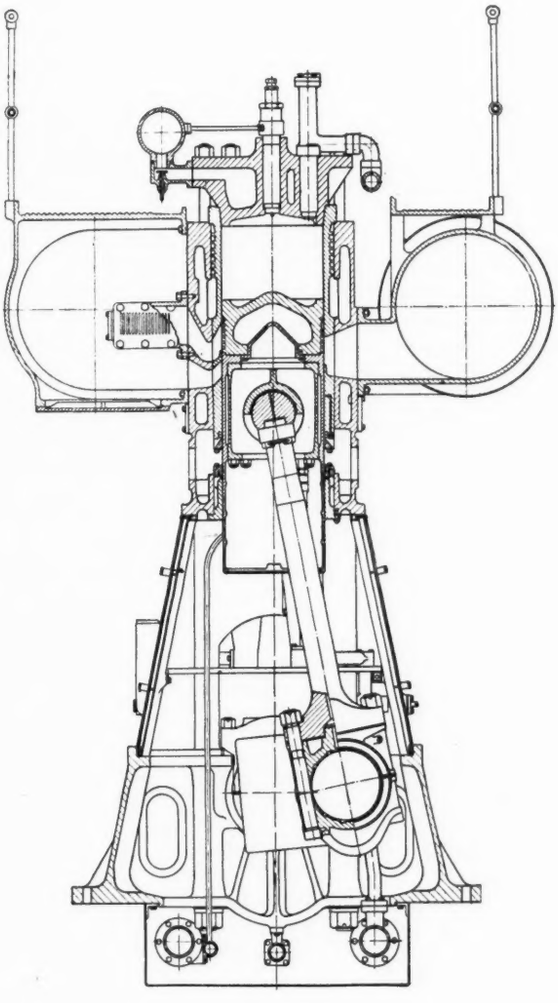
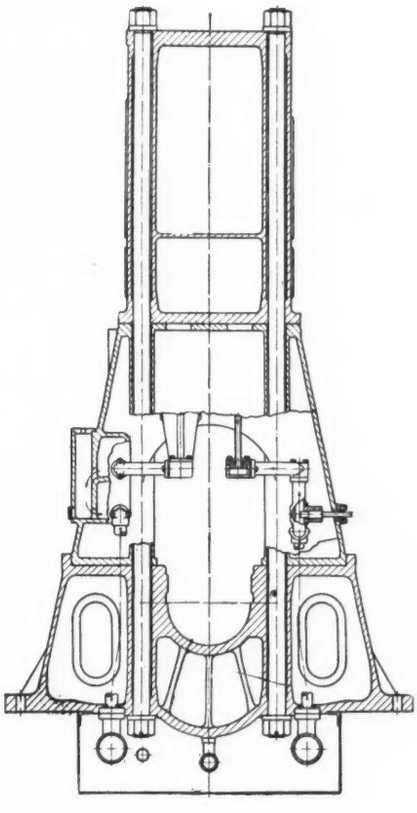
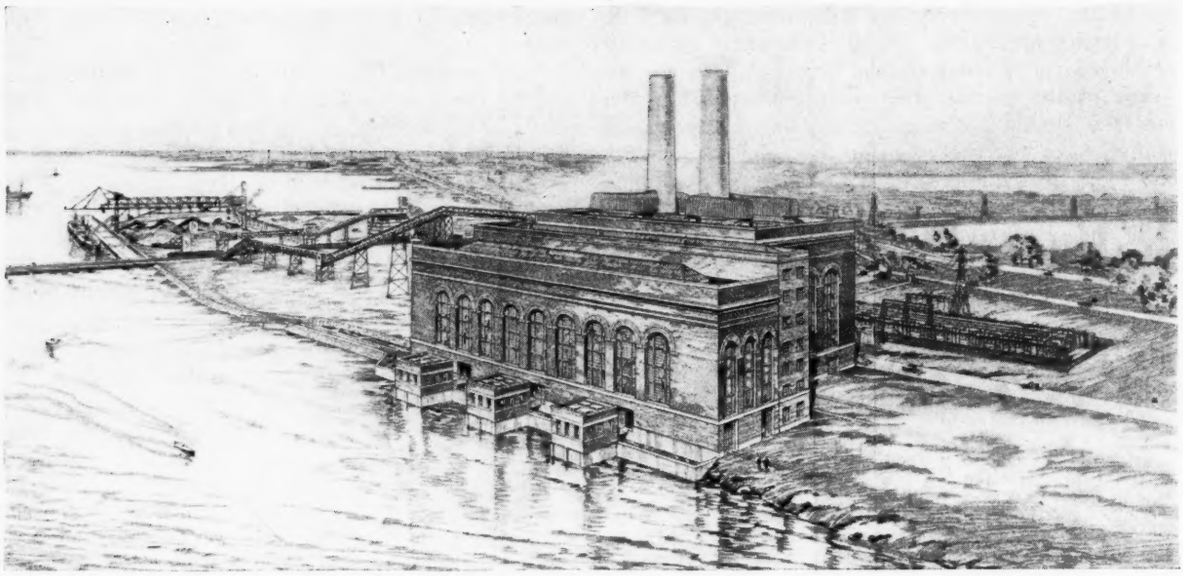


Fig. 2 (Left)—Cross-section through the Busch-Sulzer Hesselman engine

Fig. 3 (Right)—The frame is made up of a cylinder block, A frame and subbase



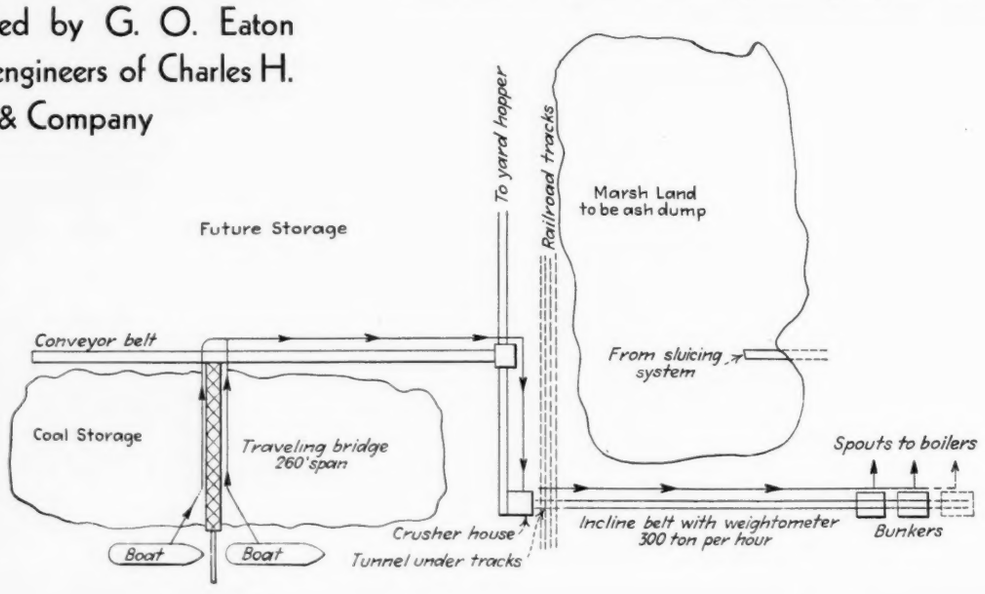


Simplicity to Mark Salem's 150,000-Kw. Plant

Two 50,000-kw. generators and four 20,000-sq.ft. boilers planned for initial installation. Decision on method of firing awaits final studies. Steam pressure will be 450 lb., with provision for addition of 1,400 lb. units. This article is based on information supplied by G. O. Eaton and C. A. Turner, engineers of Charles H. Tenney & Company

PLANS are now nearing completion for a 150,000-kw. plant to be erected at Salem, Mass. The initial station equipment will consist of two 50,000-kw. turbine-generators, one 1,500-kw. house turbine, and four 20,000-sq.ft. water-tube boilers. Steam will be generated at 450 lb. pressure and 725 deg. temperature. The building will be designed to house equipment for an additional 50,000 kilowatts.

Before outlining the principal features of this station, it will be worth while to review briefly some of the conditions that led to its construction. Originally the region north of Boston was served by several small utilities using hand-fired boilers and reciprocating engines. These



Coal-flow diagram. The previous existence of a coal-storage yard at this point was an important factor in fixing the plant site

properties gradually joined and developed into the present network, which serves an area of about 2,900 square miles and a population of about one-half million. The present aggregate yearly output of plants in this network is about 225 million kw.-hr., with a steady annual growth. The estimated yearly output in million kilowatt-hours for 1933 is 310; for 1934, 339; and for 1937, 439.

With the economical physical limit of the present stations in sight, the need for a new super-generating station was evident.

Selection of a site in historic Salem was based upon the usual consideration and certain special ones. The harbor site chosen provides an abundance of cooling water, firm bearing for foundations, rail and dock facilities, and a location close to the center of distribution. The contour of the coast at the plant location insures satisfactory isolation from bad storms, drifting seaweeds and kelp. The average sea water temperature is 64 deg. F. during the summer months. Sharp dropping off of the ledge practically eliminates dredging for intake.

Another factor influencing the situation was the fact that a coal-storage yard of 100,000 tons' capacity was already established there, with space available for increasing to 300,000 tons. A crusher and belt conveyor would be the only new coal-handling equipment required for the layout.

Four hundred pounds throttle pressure was adopted, after a study which showed clearly that 1,400 lb. pressure would be less economical with the existing load and that expected in the near future. The same applies to 600 lb. Provision was made, however, for future developments that might render 1,400 lb. more economical.

Instead of the third 50,000-kw. unit there may be installed a complete 1,400-lb. unit (boiler turbine, etc.) exhausting through a reheater to the existing 400-lb. main.

If high pressure is not adopted later, the two units constituting the first building operation will be augmented by a third 50,000-kw. turbine-generator and four more 20,000-sq.ft. boilers.

From the point of view of architecture and engineering, several features of the building and its layout are of interest. In layout the straight-through sequence has been followed strictly. The plant has been designed to reduce the operating force to a minimum.

The buildings, of fabricated steel frame and brick construction, will be pleasing in appearance but without unnecessary ornamentation. Exterior walls are to be of red brick, and interior walls of white glazed brick, thus avoiding the necessity for frequent cleaning and painting.

To avoid the expenses of washing and maintenance, and the nuisance of frost, condensation and dust, windows will be minimized as far as possible in the final design. It is considered better to use artificial light and ventilation, particularly around electrical equipment.

The main building will consist of three longitudinal bays, the turbine room bay, pump-and-station-auxiliaries bay, and boiler room bay.

Boiler units will be designed for forcing to 500 per cent. of rating. Plans for firing by stokers and by pulverized fuel from individual mills have been laid out.

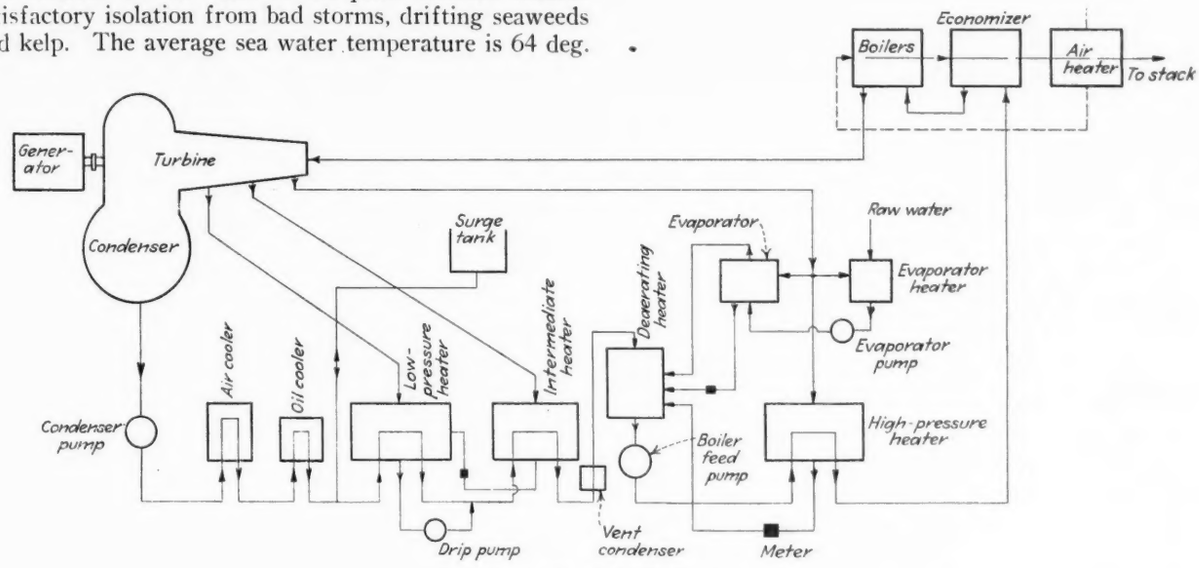


Diagram of feed-water system

Final decision on this point awaits the result of another study.

Present plans call for the use of automatic combustion control. To prevent any possible nuisance, or claim of nuisance, by abutting property owners, provisions for cinder traps and dust catchers will be made, although this equipment will not be put in at first.

A general diagram of coal flow is shown on the preceeding page. Note the use of a weightometer for the benefit of the purchasing department.

The flow of coal from bunkers to the boilers will be through four automatic weigh scales. In selecting weigh scales, it was felt that the higher equipment cost would be more than counterbalanced by a saving on construction cost, and of three men per day in operation. Furthermore, this arrangement permits continuous check of the performance of each boiler, and the maintenance of perfect balance throughout. This is important when large boilers are being driven at 500 per cent rating.

The overhead bunker, which will be fed by belt conveyors in duplicate, is of steel, concrete lined, and of 520 tons capacity. This will later be increased to 1,000 tons.

A hydraulic-jet ash-sluicing system will deliver the ashes onto the tidal flats, otherwise waste land.

As is usual in modern central station design, motor-driven auxiliaries will be used throughout, but with steam stand-by drive on the more important units.

The design reduces as far as possible the amount of

steam piping and the number of valves and fittings. Each turbine, with its boilers, is a complete steam unit, with one cut-over line between the two systems and an auxiliary header run for station use. All main valves are motor-operated. The piping will be electrically welded. A general color and banding scheme of designation will be applied to all piping.

The electrical layout, like the mechanical, is designed for the utmost simplicity consistent with dependable operation.

As previously mentioned, practically all auxiliaries will be electrically driven. Power for the essential auxiliaries will be obtained from transformers connected solidly to the generator leads. Non-essential auxiliaries will be fed by transformers from the 66,000 volt bus.

All auxiliary buses operate at 2,300 volts. Auxiliary motors of 50 hp. and up will operate at 2,300 volts, smaller sizes at 550 volts. A house turbine of the quick-starting type will be connected to these buses, but will be operated only for emergency.

The designs and studies for the Salem station were made by the engineers of Charles H. Tenney & Company under the personal direction of S. C. Sargent, vice-president in charge of engineering.

Vemork Reaction Turbine Operates Under 918-Ft. Head

AS ORIGINALLY constructed, the Vemork hydro plant of the A. S. Rjukanfos, Oslo, Norway, had installed eleven 15,000-hp. double-runner horizontal-shaft pelton wheels operating under an effective head of 918 ft. at 215 r.p.m. The maximum head on this plant is 950 ft. When considering the installation of another unit it was found that space limitations were not favorable for a twelfth machine of the type in operation. A study of the factors in the problems led to the decision to install a francis-type wheel.

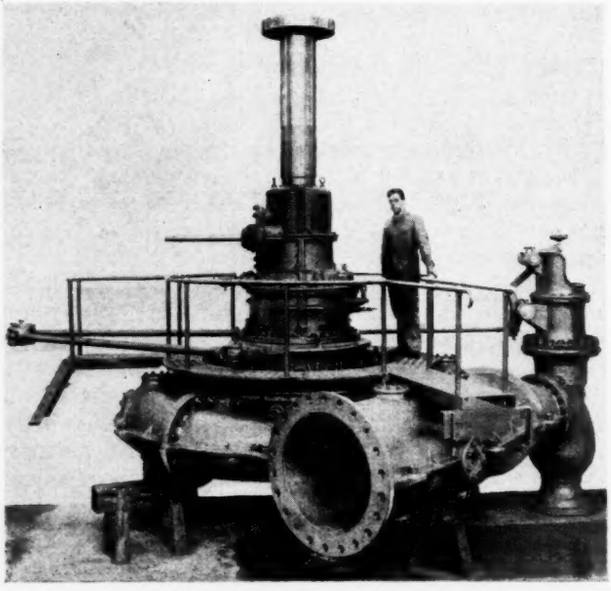


Fig. 1—The scroll case is of cast steel and is equipped with a governor-operated relief valve

This type of unit offered several advantages. The unit's high speed combined with the vertical-shaft construction resulted in minimum space requirements. Since a draft tube could be used, the total head between the forebay and tailrace could be utilized. The cost of the unit would be lower and its efficiency higher than an equivalent installation with a pelton-type machine. Water for the plant is taken from a large lake that insures water free from erosive sediment. This was another factor influencing the choice of a francis-type runner.

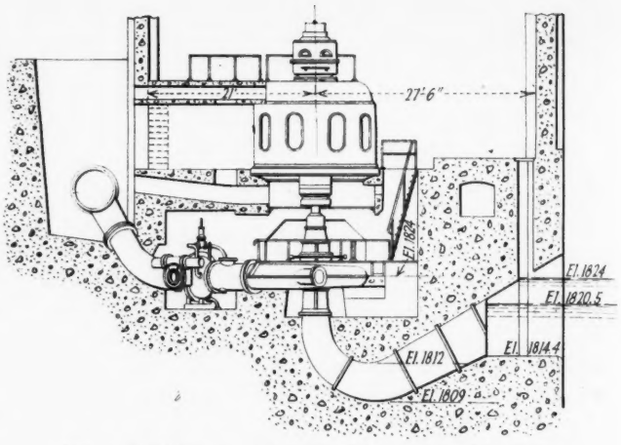


Fig. 2—Setting for 17,500-hp. 918-ft. head 600-r.p.m. francis turbine

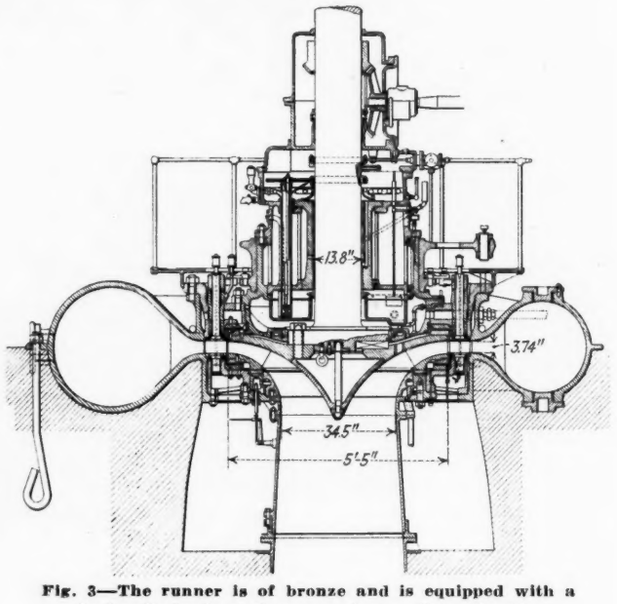


Fig. 3—The runner is of bronze and is equipped with a hydraulic brake acting on a ring on its underside

The effective head, 918 ft., under which this unit operates is one of the highest used on a francis-type runner. It is rated at 17,500 hp. at 600 r.p.m. and a specific speed of 15.55 in the English units and 69.2 in the metric system. The manufacturer, Escher Wyss & Company, guaranteed a maximum efficiency of 90 per cent for the turbine. On test a maximum efficiency of 91.4 per cent was obtained at 16,000-hp. load. Between loads of 14,500 and 16,800 hp. the efficiency was 90 per cent and above.

Figs. 2 and 3 give a general idea of the turbine's design. The scroll case is of cast steel and is equipped with a governor-operated relief valve to bypass the water in case of a sudden rejection of load. The runner is of bronze and is equipped with a hydraulic brake acting on a ring on its underside. This brake can be used to lift the total rotating element if necessary.

Scheduled Inspection Cuts Maintenance Cost

By MARIN PHILLIPS

A SYSTEMATIC inspection program is the diagnosis chart of machinery and equipment. It is to this chart that those in charge of plant maintenance look in order to transmit service to the right department at the right time.

The frequency of inspection will depend on the type of equipment and the severity of operating conditions. To start a regular schedule of inspection in a plant merely means applying past experience and assigning a routine inspection schedule.

How frequently inspections should be made is a guess to start with. When the inspection schedule has been in operation for a time and the condition of the equipment has been determined as found at inspection periods, the time that can be allowed to elapse between inspections may be accurately decided and the dates changed accordingly. After inspecting the equipment a few times, it may be found that the periods between inspections in some cases are too long while in others longer periods between inspections can be allowed. Leaving too long an interval between inspections invites delays at a time when it is inconvenient to make repairs. An example of letting inspections go too long is found in oil circuit breakers. If the arcing contacts are not replaced before they are badly burned the arcing will be transferred to the main contacts. This burning will develop poor contacts, resulting in overheating and, eventually, delays and expensive repairs.

Choosing Inspectors

The inspector should be a trustworthy mechanic with sufficient training and experience to know what to look for and what to report. He should also know when a machine is operating or functioning properly. It may also be an advantage for him to know how to make adjustments properly if his routine will permit it. Oilers and other workmen, whose duties carry them to all parts of the plant, are the best type of raw material from which to develop inspectors. Very often a few minutes' inspection of a machine and its working parts will save serious delays as well as an expensive repair bill.

Inspection properly carried out will reveal worn or broken parts that can be repaired or replaced before they fail in service. It will generally show impending trouble far enough in advance to allow ordering necessary repair parts and material needed to make the repair, and thus allow reducing the amount of materials carried in stores. Minor adjustments can be made that otherwise might develop into serious trouble and repairs.

When an inspection is properly made it will list the findings under machinery repairs, adjustments, items that require immediate attention and those that require watching. Abuses in operation, improper lubrication and unusual operating conditions that will shorten the life of the equipment will be detected.

When an unexpected machine failure occurs time is lost getting repairmen and tools to the job and getting the work started. If a machine fails in service it may endanger or wreck other equipment. There is also the personal safety side of the question. Many serious accidents to life and property have occurred as a result of some minor part of the machine not working properly or failing in service.

An important item in maintenance scheduling that goes toward cutting cost is concentrating the work: In other words, bringing into one department the necessary tools and materials and putting that department in first-class operating condition rather than doing a small job and then moving workmen, tools and supplies to another part of the plant for another small job.

Some system of recording when work was done and when it is due again is necessary. When a maintenance schedule is carried mentally there are a great number of small items, and large ones as well, that are apt to be overlooked. These may be of importance to successful plant operation. A recording maintenance program must be so laid out that no item will be overlooked. Such a system, properly functioning, gives a daily picture of plant conditions, making it possible to obtain a closer control of maintenance.

Filing Systems for Records

Several different kinds of filing systems are in use for periodically checking up on maintenance work, such as charts, filing cards, equipment records, etc. Some are operated with very little labor, while others are so complicated that they defeat their own purpose. A maintenance scheduling or filing system has to be as simple and easily operated as possible to be effective, otherwise it will not be followed as orginally planned.

Each particular plant has its own operating methods and conditions, which no "tailor-made" maintenance program or record system will fit. It is up to those in charge of plant maintenance to formulate their own program and record system. A maintenance scheduling system has to be flexible. It cannot be laid down in concrete form and followed exactly on schedule, because many variables enter into plant operation, and unforeseen work and emergencies cannot be scheduled.

Making Repairs Ahead of Time

Sometimes it will be to an advantage to do certain jobs ahead of time or hold them in abeyance. It may be necessary to take a steam turbine driving an electric generator out of service for repairs a few months ahead of the time scheduled for the inspection and overhauling of the electrical equipment. If this electrical work is going to require a shutdown affecting production, the work should be done while the unit is down for turbine repairs. The same holds true in case the electrical work needs to be carried out ahead of a contemplated repair job on the turbine. Likewise, the steam plant may have to be shut down completely for repairs. This is the time for all departments to get busy on leaky valves, gaskets and other maintenance work that cannot be carried out with steam pressure on the mains. Such major jobs as these should be planned far enough in advance to allow every one to check up on his needed work and prepare for it.

The ideal maintenance schedule is one that, when systematically carried out, will keep all equipment in good condition. Then, if necessary, a period of inspection on any particular machine may be skipped without the risk of suffering a failure or delay in case other urgent work prevents the schedule from being followed. For this reason it is best, and in most cases cheaper, to schedule the frequency of inspections to about one-half the time experience shows the equipment will operate before serious trouble develops.

Controlling POWER FACTOR Automatically

By AUBREY SMITH

Industrial Engineering Department
General Electric Company

By a proper selection of motors in a large industrial plant it is possible by automatically controlling the field current of a large synchronous motor, to maintain the plants power factor at unity. A very favorable power rate is obtained because of the high power factor and other operating conditions

LARGE industrial consumers of electric energy are coming to realize that certain definite economic advantages are enjoyed by plants that operate at the highest possible power factor consistent with over-all plant economy. Present-day power contracts usually give the customer a premium for maintaining a desirable power factor or penalize for lagging power factor lower than certain specified values. The problem arises, therefore, of balancing the benefits obtained, such as lower charges from the power company and improved operating conditions, against the increased cost of equipment necessary to obtain the proper power-factor conditions.

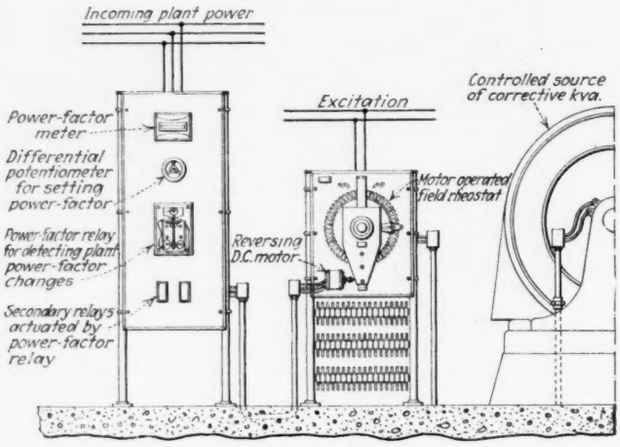

Incoming plant power
Power-factor meter
Differential potentiometer for setting power-factor
Power-factor relay for detecting plant power-factor changes
Secondary relays actuated by power-factor relay
Excitation
Reversing D.C. motor
Motor operated field rheostat
Controlled source of corrective kva.

Fig. 1—Simplified diagram of the essential elements in the power-factor automatic-correcting system

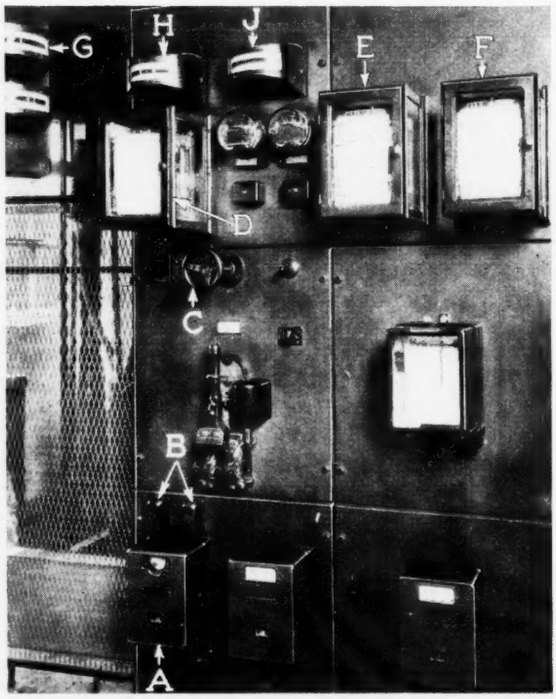


Fig. 2—Section of switchboard upon which are mounted power-factor control relays and meters for maintaining power-factor near unity

The power company enjoys certain advantages if the power factor of the system is maintained at a value unity. Among them are increased capacity of its generators and transformers, improvement in voltage regulation of its system, and decreased investment in transmission lines. An electric conductor's usefulness is limited by its current-carrying capacity; consequently, more power is transmitted over a conductor of a given cross-section at unity power factor than at any other. For example, a power system comprising generators, transformers, and transmission lines can carry, at 0.7 power factor, only 70 per cent of the kilowatt load that could be carried at unity power factor. The remaining 30 per cent is wattless kilovolt-amperes, which does no work and appears as a red figure on the balance sheet.

Recently a power contract between a Mid-Western power company and an industrial customer specified a definite time schedule of operation for each of more than 100 induction, synchronous and direct-current motors in the plant so as to limit the heavy power demands to the off-peak load periods of the power system and also required maintaining unity power factor at the industrial

plant. The inducement to meet these stringent requirements was an extremely favorable rate for energy. It devolved upon the electrical manufacturer's application engineers to devise apparatus that would automatically maintain the customer's plant power factor at the desired value.

The nature of many electric drives in the plant was such that their load power factors and efficiencies varied through wide ranges. These variables were not confined to small motors only, but were especially noticeable in some drives rated at 60, 75, 125 and 250 hp. Furthermore, the operating schedule required that 75- to 600-hp. synchronous motors on large mills be started and stopped at precise times to avoid excess-demand charges. A careful study was made of the operating conditions of each motor-driven machine in the plant as to its power demand, efficiency and operating power factor for the 24-hr. period, in accordance with the time schedule for motor operation of the power contract. Wide experience in the application of electric motors to the types of machines involved in this plant enabled close estimates to be made of the power factor and efficiency that would exist in each drive. A summation of these values for the entire plant for each of the nine major periods into which the day was divided determined the plant power demand and the leading or lagging reactive kilovolt-amperes involved for each period.

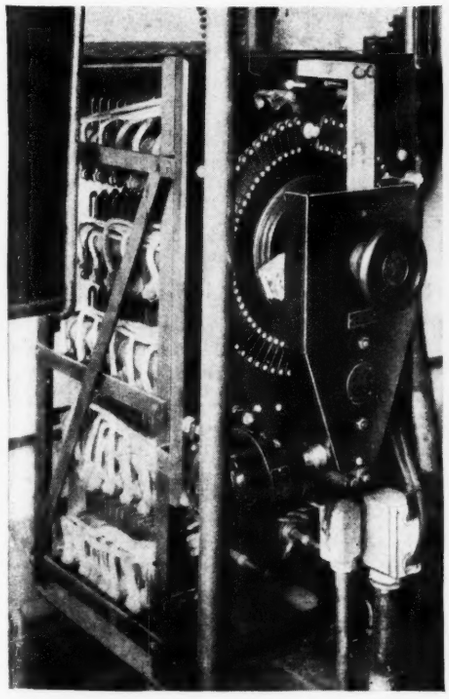
Since the rated power factor at which the synchronous motors to be installed would operate when fully loaded had an important bearing on the total of unbalanced reactive kilovolt-amperes for each period, various values of power factor rating for these motors were tried. Furthermore, since certain machines may be operated by either a synchronous motor or an induction motor, variations in this respect also directly influenced the amount of unbalanced kilovolt-amperes required in certain periods. Finally, a complete scheme of motorization involving direct-current drives for certain adjustable-speed units, induction-motor drives for the great majority of machines and synchronous-motor drives for most of the units requiring large power was selected.

This plan was effective in minimizing the unbalanced kilovolt-amperes to be supplied from an outside source to bring the over-all plant power factor to unity. The diversity of motors involved in the schedule is illustrated by the fact that synchronous motors rated at 0.8, 0.9 and 0.96 power factor were included, as were also induction motors up to 250 hp. The minimum plant load occurred for one hour in the morning and was slightly less than 700 kw., whereas the maximum prevailed for seven hours at night and was about 2,500 kw. Despite this variation and the inflexible nature of the plant flow sheet, the motorization plan indicated that over-all plant power factor could be maintained at unity by supplying a maximum of 750 reactive kilovolt-amperes from an automatically controlled source.

The need of direct-current motors in certain adjustable-speed drives where accurate speed adjustment was necessary, together with the excitation power requirements for synchronous motors, made up a direct-current load of 300 kw. It was decided to drive this direct-current generator by a synchronous motor capable of supplying the 750 leading reactive kilovolt-amperes, or a maximum of 300 lagging reactive kilovolt-amperes, as desired, in addition to driving its 300-kw. load. The problem was to develop apparatus that would continuously apply the proper wattless kilovolt-amperes to the plant's incoming line so as to balance the plant power factor at a point near unity, thus avoiding power-factor penalties.

The solution of this problem obviously required the development and application of apparatus directly and continuously responsive to power-factor conditions on the incoming line. The essential operating elements of the system are shown in Fig. 1. The primary power-factor relay detects the plant power-factor changes, and the two secondary relays are actuated by the power-factor relay whenever it functions to modify plant power-factor conditions.

The design of the power-factor relay is such that one group of its actuating elements is responsive to the current conditions in the line to which it is attached, while



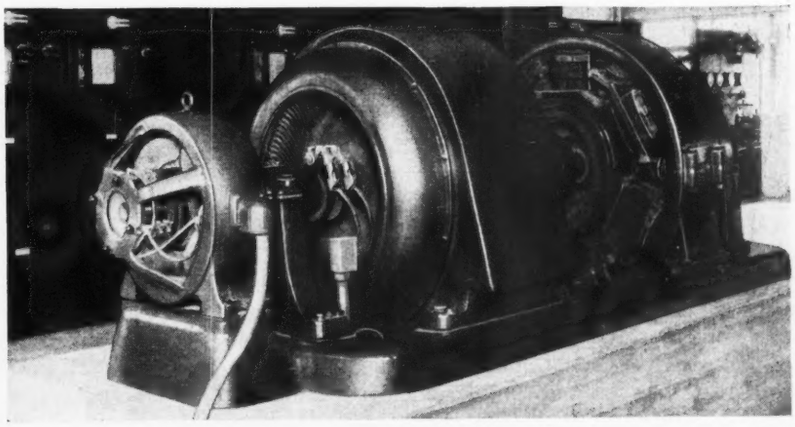


Fig. 4—Motor-generator set for power-factor connection in the switchboard room of the Ash Grove Lime and Portland Cement Company, Louisville, Neb.

Fig. 3—Motor-operated rheostat that controls the current in the field coils of the synchronous motor. The movement of this rheostat is controlled by relays operated by the power-factor relay, the action of which depends on a differential potentiometer setting. After the initial adjustment of the potentiometer the entire operation of equipment is automatic, supplying the proper amount of reactive kva., leading or lagging

the other group of elements is responsive to the voltage conditions in these lines. A differential potentiometer with an adjusting handle is so connected in the circuits which energize the potential elements of the relay that the power-factor condition which the primary relay is to maintain may be adjusted over a reasonable range, as, for instance, from 0.95 lagging to 0.95 leading.

When the differential potentiometer is set to maintain unity power factor the movable element in the power-factor relay remains in the neutral position only when the

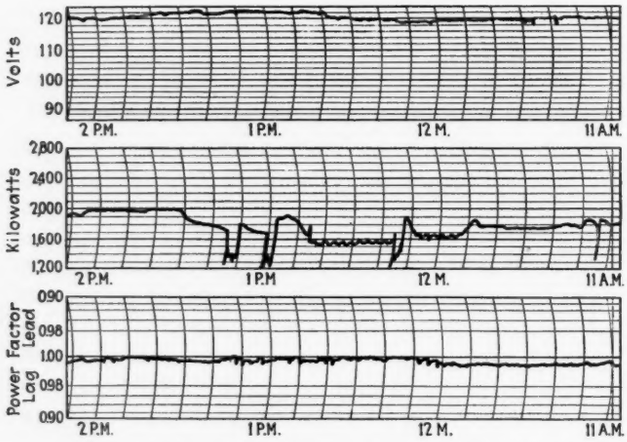


FIG. 5—CHARTS OF POWER-FACTOR, INCOMING PLANT KILOWATTS AND VOLTAGE RECORDED BY GRAPHIC INSTRUMENTS

The fidelity with which the power-factor was maintained near unity is illustrated by the bottom curve, the maximum deviation, of only 1 per cent, occurring at 12 M.

current and potential of the incoming line are in phase. Following a certain period in the daily plant routine in which normal operation of the motors gives an over-all plant power factor of 0.95 leading, certain synchronous motors are shut down. This is followed immediately by starting some of the large induction motors, which inherently operate at a lagging power factor. Considered only from the instant at which the power factor of the incoming line passes through unity, at which time the movable element of the relay is in the neutral position, the functioning of the corrective apparatus is as follows:

When the movable element of power-factor relay, *A* Fig 2, is deflected to one side because of a lagging power factor, it closes contacts that actuate one of the secondary relays *B*. The latter closes a circuit through one of the two opposing series fields of a direct-current motor operating an adjustable rheostat, Fig. 3, in the field of the synchronous motor, Fig. 4. The direction of rotation of this direct-current motor is such that resistance will be cut out of the rheostat, the synchronous-motor field will be strengthened, and the leading reactive kilovolt-amperes supplied by it increased. This operation continues until sufficient leading wattless kilovolt-amperes is derived from this source to bring the over-all plant power factor to unity, at which point the power-factor relay element again assumes a neutral position. By properly laying out the adjustable-field rheostat and gear reduction by which it is driven and supplying a quick-acting driving motor, the response of the whole apparatus to sudden variations of the plant power factor is rapid. The operation of this mechanism in the reverse direction, that is, responsive to changes of plant power factor from lagging to leading, is equally efficient.

Should it be desired to maintain a plant power factor other than unity, an adjustment of the potentiometer in the proper direction, by control wheel *C* instantly shifts the condition under which the power-factor relay will remain in a neutral position. If this desired condition was such that at any time it required more than 750 kv.-a. to balance the plant load to the desired value of power factor, an alarm would ring at the extreme point of operation of the adjustable-field rheostat. The operator would then know that an additional block of reactive kilovolt-amperes had to be obtained from another source if the condition for which the potentiometer had been set was to prevail.

Operating Results

Fig. 5 graphically illustrates the results obtained with the equipment during a typical performance period. These three charts were taken simultaneously by the graphic power-factor meter, the graphic totalizing wattmeter *D* and the voltmeter *E*, Fig. 2. The power-factor curve reveals that the deviation of the plant's power factor from unity was negligible notwithstanding wide variations in load. Between the hours of 11 a.m. and 2 p.m. the incoming-line kilowatts varied between wide limits; at 12.15 p.m. it dropped as low as 1,200 kw.; and at 1.35 p.m. it reached a maximum value of 2,000 kilowatts.

While no attempt was made to hold the line voltage constant, the voltage chart indicates negligible fluctuations ranging from 118.3 to 122.5 volts, or about 2 volts above or below a mean value of 120. The obvious conclusion from these simultaneous recordings is that excellent power-factor conditions were maintained, and incidentally, good voltage regulation, even with wide deviations in over-all plant load and operating conditions.

Power-factor correction is not a panacea for all ills incident to power generation and distribution, but in many instances remarkable improvements have been accomplished by an analysis of existing conditions followed by the appropriate remedy. When the current-carrying capacity of an existing system has been reached and conditions of operation are bad, because of low voltage, correction of any low power factor existing often effects a decided improvement.

Given proper consideration during the layout of a new industrial plant, provision for proper plant operating conditions with respect to power-factor, voltage maintenance and machine capacity may be accomplished with the minimum of expense and inconvenience.

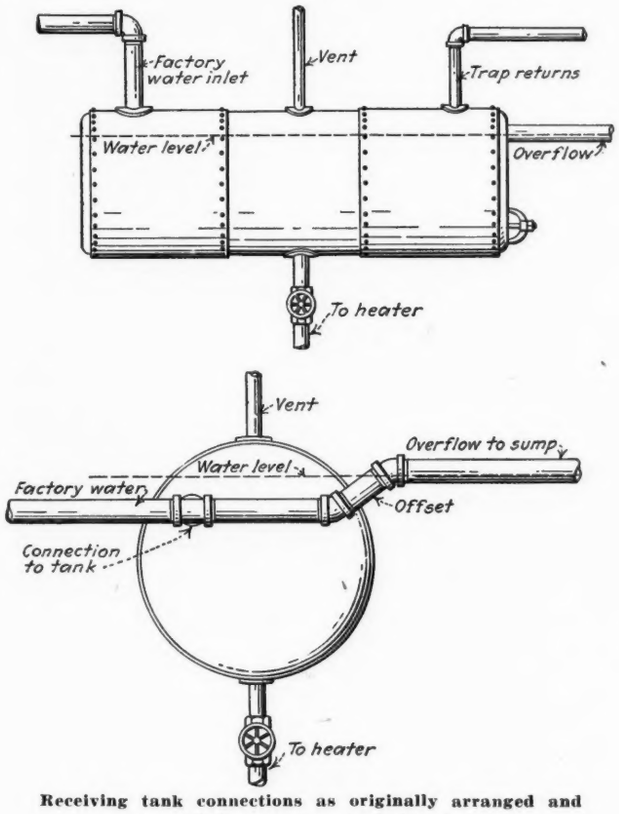
▼

A Summary Report of a survey of low-pressure steel-heating boilers, recently conducted by the division of simplified practice of the Bureau of Standards shows that 21 firms representing over 90 per cent of the 1930 output reported total shipments of 7,805 steel boilers, of which over 76 per cent were of the welded combination type. Of the total shipments, 3,036 boilers were to be mechanically fired. Eighteen different kinds of boilers were reported, each made in from 6 to 132 different capacity ratings. The total variety aggregated 1,072. An analysis of the two most popular kinds of boilers showed that over 84 per cent of the sales were made in 20 per cent of the capacities produced, and that no shipments were made in over 28 per cent of the capacities produced.

...RIGHT OUT OF THE PLANT...

Stabilizing Water Level in Receiving Tank

WATER fed to the boilers in an industrial plant was first used in certain processes of manufacture and in the jackets of compressor cylinders. The feed water was pumped from an open heater supplied through a float-controlled valve. In order that the factory water should flow to the heater under a constant static head, a receiving tank was suspended at an elevation of about 12 ft. It was figured that this would avoid any tendency of the float-controlled valve to work erratically, as it probably would under a varying pressure.



Receiving tank connections as originally arranged and remodeled arrangement of the piping

Factory water entered the receiving tank through an opening in the shell close to one head and overflowed through an opening in the opposite head, as shown in the upper view of the illustration The hot water discharged by the many steam traps in the works also was piped to the receiving tank. But as the tank was constantly overflowing to a sump, from which the excess water was pumped to a cooling tower and recirculated through the factory, much of the heat in the condensate from the traps was lost.

To eliminate this loss it was proposed to plug the outlet, pipe the factory cooling water directly to the sump and run a branch from the main discharge line to the receiving tank, with a float-controlled valve in the branch to regulate the supply.

But that plan was abandoned in favor of the simple arrangement shown in the lower view. Here the main current of factory water goes through to the sump, while the offset formed by the 45-degree elbows insures that enough of it is deflected to the receiving tank to maintain a constant level, the overflow outlet being plugged. All of the heat carried in the trap returns is absorbed by the water flowing to the open heater.

St. Louis, Mo. A. J. DIXON.

Heat and Power Costs in Hotels

IN THE Feb. 17 number of *Power* there was an interesting article for operating engineers, especially for engineers in hotels, on the cost of heat, light and power in hotels.

Mr. Romine's report, to me, was very constructive, even though I do not agree with him or his method of arriving at his figures. It is my opinion that a fair report of this kind would be based on the following, at least: the kilowatt demand; the kilowatt-hours per room per year, coal per year; coal per room per year; cost of coal per million cubic feet of building; cost per thousand pounds of steam; tons of ice or the cubic feet of refrigeration space; cubic feet of water; salaries; and repairs.

The item of electrical consumption should not vary, unless it goes up under purchased current due to the high voltage on central station lines. With the same lamps and motors in operation and the same voltage the kilowatt-hours should be the same. In all probability this report is based on old power plants with the machinery pretty well worn out. If the report had been taken from a modern building I feel sure that the figures would have been different.

The Belvedere Hotel has had some experience along the line of generating and purchasing current. A test for a period of two weeks was made, one week with generators running and one week with purchased current. With generators running, the light meter registered 9,440 kw.-hr. With purchased current the light meter registered 9,640 kw.-hr. This building operated for more than eight years on purchased current, and for the last

five years has operated on its own power plant. One question Mr. Romine did not raise (perhaps it was not asked in his report) is "do hotels purchasing current consume more lamps than hotels operating their own power plants?" It was our experience that we saved considerably on lamps after starting our plant.

Costs may vary considerably for reasons beyond the control of the owner, manager or chief engineer. Take two buildings of the same cubical content. One building may have six stories and the other fourteen. The six-story building may have four elevators, and the fourteen-story building ten, all hydraulic. One can readily see which one will use the most coal or electric current for elevator service. Bathrooms are another item in the cost of operation. Public space should also be given the consideration it deserves.

Coal consumption does not run true to form in the report. The 250-room hotel consumes $1.383.40 more than a 600-room hotel, and both buildings have high pressure and burn the same kind of coal. Taking the 300-room hotel, which consumes 52 per cent more coal than the low-pressure hotel, five hundred tons of coal is a considerable amount to blame on the pressure alone. It is a well-known fact that the high pressure will eat more steam through an orifice than low pressure; if all things are equal in these hotels, it is reasonable to draw the conclusion that the difference is caused by leaks.

Daily records should be kept in every plant in order to compare today's costs with those of the past year. Permanent meters should be installed in all power plants for this purpose. If these are not obtainable, portable instruments should be available. These meters would tell why the department costs had been increased or decreased. They would also tell when and why this or that machine should be taken out of service for repairs.

HENRY E. NELSON, *Chief Engineer,*
Baltimore, Md. Belvedere Hotel.

Altered Drainage Connection Removes Cause of Water-Hammer

ON PAGE 375 of the March 3 number, A. J. Dixon describes a change made in a one-pipe heating system to remove a cause of water-hammer. In my opinion, a much better way of making the offset would have been to use a tee in place of the lower elbow. Then as large a drip as desired could be used from the bottom end of the tee to the tank above the water line. This would be a more practical arrangement.

Usually the condensation return from a low pressure heating system has a check valve on it. Then, if the pressure rises in the tank or a vacuum forms in the heating return on live steam main to which the drip is connected, there will be no danger of the water in the tank flowing into the lines.

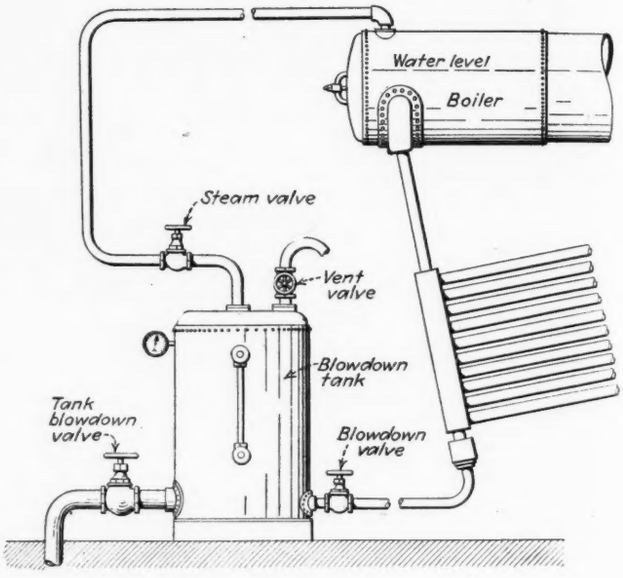
When a check valve is used, however, the high water level of the tank should be at least 2 ft. below the steam main. If the presures in the supply main becomes the same as the pressure in the return the 2-ft. column of water will give the additional pressure necessary to lift the check valve disk off its seat and allow the condensation to enter the tank. JAMES E. NOBLE.

Toronto, Ont.

Slow Blowdown System for Boilers

THE ILLUSTRATION shows an arrangement designed to permit a boiler to be blown down slowly and the quantity of blowdown to be measured.

A blowdown tank capable of withstanding the full boiler pressure and fitted with a steam gage and water gage glass is connected to the boiler as shown. In



Boiler can be blown down under balanced pressure or at any pressure differential

operation, the tank is first filled with steam to the pressure in the boiler by opening the steam valve. As soon as the full pressure is attained the blowdown valve is opened and water allowed to flow into the tank through the regular boiler blowdown. When the desired level has been reached in the tank as indicated by the gage glass these valves are closed. Then the drain valve and vent valve are opened and the water allowed to drain from the tank. By determining the capacity of the tank and recording the number of fillings an accurate check can be made on the amount of water blown down.

Where it is desirable to accelerate the blowdown, this can be done by closing the steam valve and releasing some of the steam to atmosphere or heater. In this way any pressure differential can be obtained between the tank and boiler and the desired blowdown rate maintained.

Garden City, Herts, England. W. E. WARNER.

A Challenge to Engineers

THE EDITORIAL in the March 24 issue entitled "A Challenge to Engineers" is timely and to the point and affords food for thought.

Occasionally there is, however, another side to the question of engineering reports that are developed for bankers, and it sometimes happens that certain so-called investment bankers are much more interested in handling a big bond issue than in the cold facts as developed in a competent engineering report.

It is well known that there is plenty of profit in certain kinds of underwriting, financing and bond issues.

as handled by many so-termed investment bankers, and if the facts shown by the engineer's report do not readily lend themselves to the carrying out of the proposed financing scheme, the bankers may prefer to disregard the report, at the same time criticising the engineer as a poor business man.

A number of concrete examples from my experience and observation can be cited to show what sometimes is expected of the engineer when making such reports.

A certain concern desired to float a bond issue on some three or four ice plant properties located in two different states. The bankers to whom the president applied were anxious to handle the transaction, since it meant a very sizable profit to them.

The first engineer who was approached by the bankers and owner jointly and asked to make a report and appraisal was told plainly what they desired the report to show in the way of sound values and earning power. In fact, the owner went so far as to say that he had all detailed costs and total values of the properties and all that the engineer need do was to use these figures, build up his report, certify to his findings and collect a fee.

It happened that the engineer knew intimately the condition of these plants, the operating methods that prevailed and certain things concerning the management, so he declined to accept the liberal offer made for a report.

He realized that if he reported the facts as he knew them there would be trouble and dissatisfaction, and he did not care to become a party to the affair.

Later, another man, not an engineer, did make an examination of the properties in question, rendered an unfavorable report and was abused for his honesty.

In another case several similar properties were appraised, and the report submitted fitted so well into the wishes of the investment bankers that a company was formed to take over the group of plants. Bonds were sold to the investing public and operations began. In less than three years a receiver was appointed to conduct the business. The reported sound values were from two to three times higher than the actual values, and the prices paid for the properties were in many instances much greater than new and strictly modern plants would have cost.

Engineers might sometimes question the infallibility of certain bankers.

C. T. BAKER,
Atlanta, Ga. *Consulting Engineer.*

Faulty Commutator Caused Armature Failure

THE ARMATURE of a generator used to supply power to a near-by manganese mine was brought to our shop for repair. An examination showed that most of the coils were damaged. It was decided that a new winding was necessary. After removing the coils and cleaning the commutator, the latter was tested and found to be in seemingly good condition. When rewinding was completed the insulation resistance was tested with a megohm meter, which indicated about 15 megohms.

The armature was put into an oven and heated prior to varnishing, and when it was fairly hot another insulation test was made. This time the insulation resistance was 10,000 ohm only. When the heat was switched off and the armature began to cool the insulation resistance increased and at the end of an hour reached about one megohm. Applying heat again caused the insulation resistance to decrease.

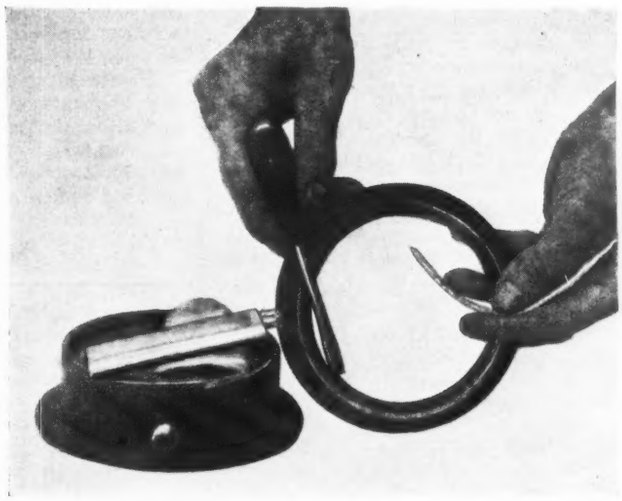
One of the coils was suspected of being faulty. All of the leads were disconnected from the commutator, but none of the coils tested less than 20 megohms. The commutator bars were cleaned and their ends were varnished. This time the armature was put into the drying oven without connecting the coils to the commutator. After an hour's heating, the insulation resistance of two adjacent bars was found to be breaking down to the shaft. Removing the commutator revealed a hole burned in the mica ring, with bits of copper trapped in it. The commutator was repaired and stood the test when heated, after which winding of the armature was completed. The armature was installed in the machine and operates satisfactorily.

The engineer in charge of the plant told me that the machine had been giving trouble, due to unsteady voltage, before it burned out. Apparently there must have been a weak or metallic spot in the mica ring through which arcing occurred that eventually short-circuited the windings and burned out the coils.

Nagpur, India. F. C. BULSARA.

Practical Method of Tightening Gage Ring Glasses

WHERE time can be taken and facilities are at hand, gage ring glasses are usually set in the ring with a mixture of plaster of paris or other easily cleaned, and not too hard, filling. Often, however, it is necessary to



How glass is tightened in gage ring by means of tinfoil

set a glass with nothing of that nature available. And if the glass has been cut with rather primitive tools, as is often the case, it should be set in with some kind of a retaining material.

The illustration shows a practical method of setting with tinfoil, which is rolled into a long, stiff and somewhat flattened strip. It is pushed into place with the glass, and further packed with the point of a small screw driver. A ready source of such foil is old Ford ignition coils.

F. W. BENTLEY.
Missouri Valley, Iowa.

From Among Readers' Problems

Conducted by
L. H. MORRISON

TOTAL HEAD ON CENTRIFUGAL FAN—*Will you explain how the total dynamic head on a centrifugal fan is measured? A certain fan company uses the formula: Resistance pressure + discharge velocity head = total head. In calculating the overall efficiency should not the fan be charged with the velocity head at intake?* C.J.W.

The total dynamic head of a centrifugal fan may be obtained by the formula:

$M = c + d - K + l$, when

M = total pressure
c = total pressure in discharge duct $= a \times b$
a = average velocity pressure in discharge duct, inches of water
b = static pressure in discharge duct, inches of water
d = static tube reading in inlet duct
K = velocity pressure in inlet, inches of water $= \frac{Y}{1.2}\left(\frac{j}{1{,}000\ I}\right)^2$
Y = density of air in discharge duct, pounds per cubic foot
j = cubic foot of air per minute
I = area of inlet duct, square feet
l = friction correction for duct

It is obvious that the intake velocity head is not taken into consideration directly, for the energy used in raising the intake velocity is employed in overcoming friction or exists in the discharge velocity, and must not be debited twice.

The total pressure M is converted into head by the formula:

$$H = \frac{M}{12} \times \frac{62.3}{Y}$$

where Y is the density of the air.

—❖—

SOLUTION HEATING BY SUPERHEATED STEAM—*For heating the solution in saturating tanks we have available saturated steam of 135 lb. gage pressure with a maximum temperature of about 350 deg.F. The solution temperature now used is 330 deg.F. Higher temperature is desired. What is the objection to using superheated steam at the present pressure for that purpose? There appears to be an unexplained assumption on the part of the operating force that superheated steam is unsuitable for any kind of heating.* F. B.

The operating force is quite correct in the assumption that superheating steam, while maintaining the same pressure, will not enable you to raise the solution temperature unless a counter current design of heat exchanger is used or an enormous amount of steam passes through the heating coils in the solution tank.

The reason is that at 135 lb. gage, a pound of saturated steam will give up 863 heat units in condensing, with a temperature of 358 deg.F. If now you desire to heat the solution to 370 deg.F., no heat will flow from the steam to the solution unless the steam is at a temperature above that of the solution. If the heating is done in batches, and the solution is admitted cold, it will absorb heat from the condensing steam until the solution reaches a temperature slightly below that of the steam, namely 358 deg.F. If the solution temperature is to be raised to 370 deg., obviously it cannot as long as saturated steam at 135 lb. gage is in the coils. If the steam has been superheated to 400, let us say, the first action is the loss of the superheat, followed by the loss of the heat of vaporization, but as both heats enter the solution simultaneously, the average solution temperature will not go above 358 deg.F.

However, it is possible to continue the application of superheated steam and allow the saturated steam after the superheat is removed by the solution, to blow out of the coils, to raise the solution temperature. If you desire a 370-deg. temperature the superheat must be above this, for the temperature of the escaping, or used, steam must be slightly above 370 deg.. If the total steam temperature is 400 deg., the steam can drop to about 375 deg., which is a 25-deg. drop, giving a release of 1 B.t.u. per pound per degree, or 25 B.t.u. per pound of steam. The heat of vaporization, or condensation, is 863 B.t.u., so the heat given up by the loss of 25 deg. of superheat is small compared to the heat given up by the condensation, requiring an enormous amount of steam.

On the other hand, it may be possible to pass the superheated steam through a heat exchanger through which the solution leaves the tank. This would heat the solution to 375 deg.F., and permit the utilization of the heat of vaporization in the solution tank.

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REVERSING AUTOMATIC ENGINE—*How is it possible to reverse a shaft-governed engine?* V. R.

Reversal methods vary with the type of engine. Generally it is possible to remove the flywheel, reverse, and replace it on the shaft. The eccentric is then on the wrong side of the flywheel to permit connection to the valve arm. The eccentric pin, is next reversed to place the eccentric on the proper side, as are also the governor spring and parts. The engine will then run under rather than over, as before. On some engines there are extra pin supports on the flywheel arms to accommodate the spring and eccentric for reversal, the wheel need not be moved.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WHAT is the best method of joining the ends of a heavy double leather or 8-ply or 10-ply rubber belt, assuming that cementing is out of the question? L.R.B.

THE BEST METHOD I have found for joining the ends of rubber, or fabric belts is by the use of Jackson belt fasteners.

The ends of the belt are prepared in the usual way by squaring with the sides. A row of holes properly spaced and of the proper size for the bolts are punched in each end of the belt. The belt is then put around the pulleys, the ends drawn together in the usual way by belt clamps and the fasteners securely bolted on.

The largest belt I have used them on

was 36 in. wide, 12-ply thick and travelling at 3,750 ft. per minute. I have never known these fasteners to fail by either pulling out or breaking and the shortening of the belt as needed is a simple matter. W. F. O'REGAN.
Boston, Mass.

DURING my varied experience as erecting engineer, sometimes conditions made it necessary to joint a belt where cement was not available.

With a rubber belt we open each ply and take 3½ in. off each ply, to have the same number of "steps" as there are plys. I serve each end the same, fit them together and stitch with ordinary belting wire, making $\frac{5}{64}$ holes, ¾ in. apart, with a punch. Better results can be obtained on rubber if a good fishing twine is used, applying wax for lubrication. Our millwrights usually carry a small sail needle for rubber belts.

We have 10- and 12-in. belts joined in this manner that have been in operation since 1920. Wire may be used to take the place of lacing on an ordinary joint by carrying the holes further back and making four passes instead of two as with a leather lace; this joint does not pound, and if made right will last much longer than purchased joints driven in with a hammer.
Toronto, Canada. G. H. HOYLES.

I WOULD SUGGEST the use of the wire-laced hinge joint as the most satisfactory method of fastening a belt. We have used this type of joint on a belt under very severe conditions and it has given us no trouble. It also passes under idler pulleys without causing them to jump as a rawhide laced belt does.

We formerly used a rawhide laced belt but had considerable trouble with the holes pulling out and the lace strings breaking. A joint of that kind is seldom well made and it is difficult to maintain the same tension on the two edges of the belt. It is also slow and expensive to make, whereas the wire-laced hinge joint is inexpensive and requires but little time to apply.

Some types can be applied with a hammer, others with a machine. We use the alligator type, which is applied with a hammer. It is furnished with a rawhide pin, but we found a pin of soft steel or brass to have superior wearing qualities. The pin should be cut off ⅛ in. short on each side of the belt to prevent it catching. DANA D. SWIFT.
Athena, Ohio.

FROM EXPERIENCE gained while chief electrician in a paper mill in Ontario I found that the flexible alligator belt fastener proved most suitable. New rubber belting stretches considerably and it is often necessary to cut a piece out to shorten it. In the case of a one-piece fastener it is necessary to cut both ends of the belt, but in the case of the alligator fastener the pin is pulled out, one end of the belt is cut, a new fastener put on and the pin replaced.

The alligator is also particularly adaptable when used on small diameter pulleys owing to the flexible joint formed where the pin connects the two ends.

A large steel square placed on the belt as a guide when cutting will give a square end and care must be taken to get the clips on square or the belt will sag on one side.

The writer has used the alligator fastener on loads up to 85 hp. running 24 hr. per day. Pins were replaced once every six months although they were inspected once or twice a month.
HARRY H. DARLING, JR.
Smithers, B. C., Can.

ON ACCOUNT of the curvature of the pulleys a belt must be pliable longitudinally so that it can wrap itself intimately around the pulley. And because of the crown of the pulley the belt must be pliable laterally. Therefore it is logical that for best service the joint must be just as pliable as the belt itself, if possible.

It is obvious that the best joint is the one that makes the belt slipless. It must have a strength efficiency as close to 100 per cent as possible.

For lacing, only the strongest leather lace obtainable should be used and I know of no leather stronger than mineral-tanned leather. The holes, of course, should be as small as possible and should be arranged in zigzag formation similar to a riveted boiler joint in order to secure maximum joint strength and efficiency. W. F. SCHAPHORST.
Newark, N. J.

I WOULD SAY lace it. A punch should be used with a diameter about equal to the belt thickness and holes should be spaced so as to leave twice or three times the diameter of holes between holes. There should be two rows of holes spaced similar to those in boiler joints. On the working side of belt the lace strings should run straight with the belt and there should be two from each hole. On the outside of the belt they should run diagonal and cross each other.

A lace string a little wider than the diameter of the holes should be used and if it is practicable a string long enough to make the entire joint.
Leesville, S.C. OLIVER J. BRODIE.

IF THE BELT is running over large diameter pulleys at a slow speed and the load is not heavy, almost any good type of metal fastener will suffice to give a long period of service.

If the belt travels over small pulleys, whether fast or slow, it will be necessary to use good lace leather in order to stand the bending due to travel around the pulleys. If the belt has a tightener on it and runs over large pulleys, with not too excessive a load, metal fasteners, good lace leather, or clipper hooks may be used, provided the belt does not travel more than 3,000 ft. per minute.

If the belt is used in connection with an idler or tightener at high speeds, a heavy metal fastener is out of the question and only a lace leather or a hinge type of fastener can be used efficiently.

If all of the pulleys are iron and objection is raised to noise, metal fasteners certainly should not be used to meet the requirements and, in either case, if the belt is running over a paper pulley any metal fastener that touches the pulley will ruin the paper.
PERCY FERRAND.
New Orleans, La.

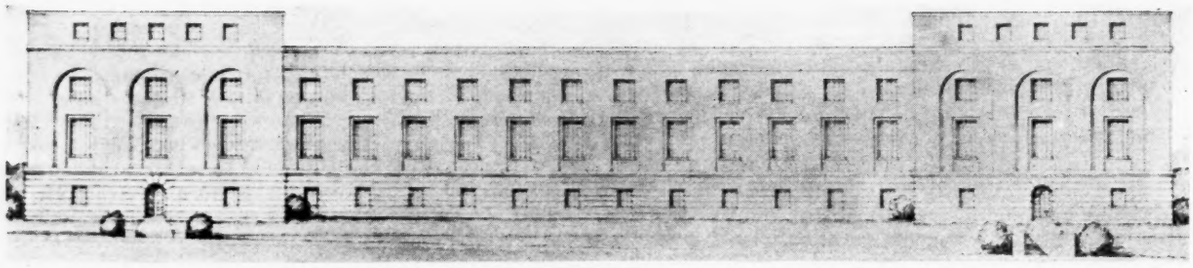
I WOULD ADVISE joining the ends of heavy belts with clipper hooks, which are applied on each belt edge and interlocked with a rawhide stick. These hooks are designed for any width or thickness of belt, and make little or no noise in passing over pulley. I have a machine, or press as it is called, here in the plant, and other industries bring me their belts to join together.
Oelwein, Iowa. J. A. WELCH.

Two Questions for Our Readers

1. We have 135 lb. steam pressure which we use to heat a solution to 340 deg. F. We wish to raise this to 375 deg. F., and some one has recommended using superheated steam direct from the boiler; our superheater gives a 400 deg. F. total temperature. But one of our engineers says superheated steam will not raise the solution temperature. Can we get a 375-deg. solution? C.C.R.

2. We are operating our turbine condenser at 29-in. vacuum. Plans are being made to install a bleeder heater to draw off turbine steam at 10-in. vacuum, and the condensate of the heater is to be discharged into the condenser hot wall. What kind of syphon seal should be used, and what is the necessary leg length? P.R.

Suitable answers from readers will be paid for and published in the May 26 number



Architect's sketch of the National Hydraulic Laboratory to be built by the United States Government at the Bureau of Standards, Washington, D. C.

Work About to Start on National Hydraulic Laboratory*

LIKE many another national undertaking, the National Hydraulic Laboratory is the realization of the dreams of a number of public-spirited men—this time hydraulic engineers, and the culmination of more than ten years of their effort. It can not be stated exactly how or when the idea developed, but it certainly lay with John R. Freeman to give the plan its initial energy and the concrete background. So, to all intents and purposes, the honor and the thanks of the hydraulic profession of the United States are due him as the originator of the laboratory. His opening gun was fired in 1919 or 1920. In 1922 Mr. Freeman, then president of the American Society of Civil Engineers, presented a paper as his annual address to the society which crystallized thought and served as the point of concentration from which the first actual progress was made.

The plan as first presented, was directed to the necessity for model experiments from which engineers could learn how to train rivers to carry their burdens of sediment to the sea. The loss to life and property from the periodical floods along the Mississippi and other of our rivers was very much in mind.

Joining forces with Mr. Freeman, a number of other prominent engineers, including C. E. Grunsky and Dr. W. F. Durand, called upon the Chief of Engineers in Washington and endeavored to convince him of the necessity and immediate practical importance of a hydraulic laboratory as a means for determining the remedial plans for holding our large rivers within their banks, against erosion, untimely deposition of silt and other destructive effects.

The Mississippi River flood of 1922 vividly emphasized the necessity for finding an engineering answer to the problem of river control. Public pressure was answered then by Senator Ransdell of Louisiana, who introduced a resolution authorizing the establishment of a hydraulic research laboratory. Hearings were held by the Senate committee and the plan was found to be practically without opposition, excepting from the Chief of Engineers of the Army and Mr. Ockerson, then president of the Mississippi River Commission. A reading of Mr. Ockerson's testimony before the committee indicates a feeling on the part of the committee members that his opposition may have been based upon the fear that a laboratory would take away from the Mississippi River Commission some of its engineering activities.

Because of these facts, and because the resolution did not stipulate in what department of the government the control of the laboratory was to be, it failed of passage. It came up again in 1924 and in 1928 after another Mississippi-River flood brought it forcibly to the front and Senator Ransdell introduced a bill, this time providing for its operation under the joint jurisdiction of the Secretaries of War, Commerce and Agriculture. The bill was considered and approved by the Budget Bureau and the President, but was blocked and defeated in the Rivers and Harbors Committee of the House. General Jadwin in December of that same year recommended to the President the establishment of a hydraulic laboratory to be under the exclusive jurisdiction of the Engineer Corps. In fact, it is understood that the recommendation was for as many hydraulic laboratories as the Chief of Engineers desired. These presumably were to be used for the solution of river and harbor problems.

In 1928 a flood-control act was passed

PROPOSED LABORATORY FACILITIES

1. Measuring tank 61½ x 45¾ x 14 ft.
2. Plant capacity for handling 250 sec.-ft. of water under a maximum head of 29 ft., with provision for a higher head.
3. Seven pumps: one 42-in. for 125 sec. ft.; one 36-in. for 85 sec. ft.: one 30-in. for 50 sec.-ft.; two for 20 sec.-ft. one for 10 sec-ft.; and three of 5 sec.-ft. capacity.
4. One rectangular concrete discharge tank 27 ft. x 26 ft. x 42½ ft. deep, with four skimmer weirs.
5. Main flume 12 ft. x 12 ft. x about 225 ft. long, with several glass windows and doors in its side walls with diverter, arranged to discharge into the measuring tank; entry section provides for syphon-spillway experiments.
6. Two small return and experimental flumes 6 ft. wide x 11 ft. deep.
7. One 8 ft.x4 ft. venturi-meter tube with meter, capacity of 250 sec.-ft.; one 3-ft.x 1½ ft. venturi-meter tube with meter capacity of 50 to 60 sec.-ft.
8. Two 20-ton weighing tanks arranged with a diverter so that either may be used for measuring continuous flow.
9. A 4-ft. glass-walled flume about 175 ft. long; later a large tilting flume will be installed.
10. A three-compartment constant-head tank, taking water from a 5-, a 10- and a 20-sec.-ft. pump. These tanks will connect into piping layouts arranged for any number of experiments.
11. A two-compartment tank supplied by two 5-sec.-ft. pumps.
12. One or two small glass-walled flumes.
13. Provisions for making various high-head experiments including the flow of water in high-building piping.
14. Two 5-ton cranes.
15. Power supply of 1,500 kilowatts.

*Abstract from an address given by Ely C. Hutchinson, editor of *Power*, before the Washington Society of Engineers, Washington, D. C., April 15, 1931.

by Congress, which gave considerable aid to the army engineers, as it authorized the use of as much of the funds as the Chief of Engineers desired to appropriate from the Mississippi-flood-control money for experimentation, research and investigations as to the best means or method of solving the Mississippi-flood-control problem. In addition, General Jadwin secured, in the then pending river-and-harbor bill, the requisite authority to establish hydraulic laboratories in connection with any river and harbor project subsequently adopted by the United States, if in the judgment of the chief it was deemed desirable. A hydraulic laboratory devoted to river-model experiments is now installed and in service under the army engineers at Vicksburg.

In the meantime, numerous hearings before the congressional committee, which prove the unflagging support for the hydraulic laboratory project under the Bureau of Standards, by such men as B. F. Groat, long an advocate of model testing for hydraulic works, Hardy Gross, L. W. Wallace, L. K. Sherman, Morris Knowles, Gardner S. Williams, A. W. Newton, John Millis, C. E. Grunsky, Hubert Engels, Gen. E. L. B. Davis, John Lyle Harrington, H. C. Ripley and others. The leading position has, however, been consistently occupied by John R. Freeman.

Original Plans Changed

As time went on, a slight change in the basic idea took place among the advocates of the laboratory. From the original plan, which apparently included the laboratory activities subsequently taken over wholly by the Army Engineer Corps as a result of General Jadwin's work, the hydraulic laboratory covered by Senator Ransdell's bill as finally passed and signed by the President on May 14, 1930, authorizes the establishment "in the Bureau of Standards of the Department of Commerce a National Hydraulic Laboratory for the Determination of fundamental data useful in hydraulic research and engineering, including laboratory research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories."

The bill also authorized an appropriation of $350,000 which was carried in the second deficiency bill, passed in May. Of this sum, $300,000 was intended for the building and $50,000 for fixed equipment. An additional $37,000 will be available commencing July 1 to cover operating expenses for the first year.

Immediately following the signing of the bill, Dr. Burgess director of the Bureau of Standards, appointed an advisory committee to consider plans. This committee consisted of Prof. S. M. Woodward, Iowa State University; L. F. Moody, Cramp-Morris Industrials Inc. and professor of hydraulics at Princeton University; E. W. Lane, Bureau of Reclamation, with C. A. Bissell as his alternate; John R. Freeman, consulting engineer and father of the project; B. R. Van Leer, assistant secretary of the American Engineering Council; S. H. McCrory, Bureau of Public Roads; N. C. Grover, Geological Survey; Capt. J. P. Dean, Office of Engineers, War Department, R. S. Patton, director of the Coast and Geodetic Survey; W. B. Gregory, Tulane University; E. C. Hutchinson, editor of *Power*. To this group there was later added Gano Dunn, president of J. G. White Engineering Corporation. Through various meetings and the earnest discussion of numerous plans, the final design was established, and bids were opened March 23 of this year for the building exclusive of machinery and apparatus.

European Practices Studied

It has been of paramount importance to establish plans which permit construction within the appropriation named and also satisfy the established architectural and building requirements for all Bureau of Standards buildings.

In the final designs utmost advantage has been taken of the studies of European hydraulic laboratories made over many years by Mr. Freeman and of the observations of others on the advisory board who have paid particular attention to the European hydraulic laboratories in recent trips abroad. So far as funds and facilities permit, therefore, the National Hydraulic Laboratory as now under construction, is representative of the best practice and the most modern thought, and will contain equipment in conformance with the best present day ideas upon hydraulic research. Through the studies of the Bureau of Standards staff and members of the advisory committee, all existing knowledge of the art has been taken advantage of.

The building will be located on the Bureau of Standards property, its major axis approximately paralleling and facing Tilden Street. It will be almost directly south of the present so-called south building and but a few paces from the present meter-rating tank and radio building. It will have a total length, including the section allotted to pumping machinery at one end and the water measuring basin at the other, of 346 ft. The width of the head or water entry section is 92 ft. and its length 81 ft. A straight-run flume section which will be devoted to the movement of the water for measurement and experimental purposes, after leaving the water supply section, will be 203 ft. 6 in., with a width of 60 ft. 3 in. Beyond this straight-run portion of the building will be the measuring tank, which will have a length of 61 ft. 6 in. and a width of 45 ft. 9 in., and an effective depth of something on the order of 14 ft. The building will be of the usual Bureau of Standards red brick with limestone trim.

It is expected that the plant will be completed and ready for operation during the summer of 1932. All credit for this splendid offering to hydraulic research is due to John R. Freeman, to Prof. S. M. Woodward, appointed by the director as Consulting Engineer in charge of design, to the advisory committee, to Director George K. Burgess, Dr. L. J. Briggs and Mr. H. N. Eaton, in charge for the Bureau of Standards.

▼ ▼ ▼

Fire Started by Cable Short Circuit Disables 5,000-Kw. Unit in Michigan Paper Mill

Fire starting from an arc below the generator, spread into the generator and destroyed the end-turn insulation of a 5,000-kw. steam turbine-generator in the plant of the Munising Paper Company, Munising, Mich., on March 28. This unit was installed in 1930 to serve the mill and to deliver current to the lines of the Cliff Power & Light Company.

Unusual conditions developed in connection with the high-line service and on the date mentioned a complete, or nearly complete, short-circuit came on. The relay tripped the main breaker, but not the field, as a control wire was disconnected. As the unit appeared to be all right the operators proceeded to restart several motors which had dropped out. After some ten minutes of seemingly proper service, and when no one was in the engine room, all lights went out and a fire was discovered in the generator.

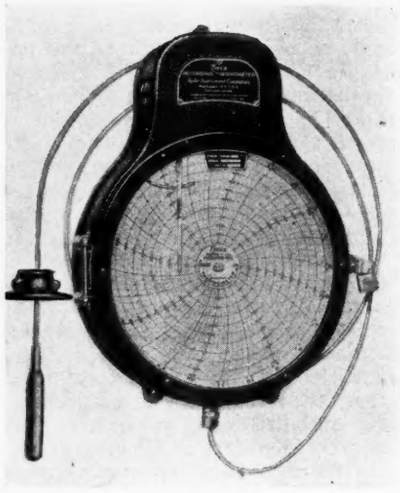
The evidence indicates that the first short-circuit, or near short-circuit, which dropped the normal 2,500 volts to 750 or lower, damaged a lug connection on an outgoing cable below the generator, and that this from heating loosened a cable which shorted on the wall of the inlet air duct in which a hole 2 ft. square was burned. The other cables parted from the unit largely from unsoldering, and a current transformer below the unit was destroyed. The fan threw the fire on the end turns.

During the fire the heat passing through the aluminum alloy fan blades caused them to fold up and unbalance the unit. The resultant vibration tripped the throttle, but even with the steam cut off the unit coasted for about 20 minutes. The damage was confined to the leads, transformer, fan, and collector end turns. No arc occurred in the generator and the winding was damaged only by the burning off of the insulation of the end turns.

Repairs are under way and service should be re-established this month. The mill is operating on other equipment and on service from the power company which supplied it before the unit was installed.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES



Instrument with compensated capillary tubing

Special Hydrometer for Continuous Blowoff

FOR A GIVEN boiler design and set of boiler operating conditions there is a maximum saline concentration beyond which steam of good quality will not be obtained. In using a hydrometer to determine this saline concentration or density (which is a measure of the concentration of dissolved salts) the reading varies according to the temperature of the liquid, a change of only 5 deg. F. being equivalent to a change in concentration of about 100 grains of salts per gallon. This means reading temperatures and making corrections with the aid of tables, or waiting for the temperature of the boiler saline to reach the exact point for which the hydrometer is calibrated.

Hydrometer for continuous blowoff

To overcome these difficulties the Permutit boiler blowoff hydrometer has been developed. With this instrument temperature corrections can be read directly in terms of density.

An integral thermometer, placed in the bulb of the instrument, makes it possible for the operator to make the correction quickly. This hydrometer is furnished with installations of Permutit continuous blowoff equipment, a description of which appeared in the Dec. 16, 1930 number, but may also be purchased separately from the Permutit Company, 440 4th Ave., New York City

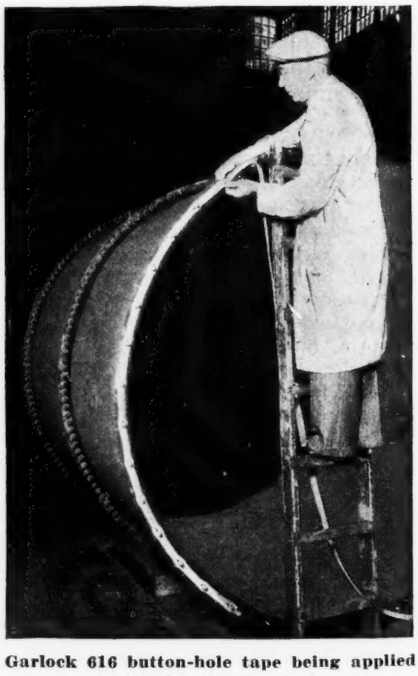
Compensated Tubing for Temperature-Recording Instruments

WITH A VIEW to eliminating possible error in the functioning of temperature instruments, due to external temperature conditions surrounding the tubing connecting the bulb to the instrument itself, the Taylor Instrument Companies, Rochester, N. Y., have produced a type of capillary tubing in which the compensating qualities have been incorporated in the material of the tube itself. It is pointed out by the manufacturer that no parts are added to the mechanism and no adjustments are necessary during the life of the instrument.

Essentially the new method consists of so proportioning the volume of mercury in the tubing to its co-efficient of expansion and to the size of the alloy wire, that any change in the volume of mercury, resulting from external temperature changes is accurately compensated. The adjustment is made for each varying exposure, and it is not necessary to compensate the instrument for the average external instrument along the length of the tubing. Welded joints are used on the tubing and the bulb is machined alloy steel.

Button-Hole Tape for Flange Gaskets

WITH A VIEW to facilitating the placing of gaskets on narrow flanges, such as generally used on large tanks and similar equipment, the Garlock Packing Company, Palmyra, N. Y., has developed a button-hole tape of unusual construction. The



Garlock 616 button-hole tape being applied to the flange of a tank

tape is made up of two parallel courses of folded asbestos cloth joined together by a single ply of bonding fabric inserted between the folds.

As suplied the tape contains no holes. These are made when the tape is applied by simply inserting a knife blade between the two parallel courses of the tape and cutting the bonding fabric to form a button hole which slips readily over the bolt or stud as shown in the illustration.

This construction, it is claimed, gives a gasket that will stay in place, fit correctly, lie flat and form a positive seal around each bolt. For joining the two ends of the tape a step joint is used.

The tape is available in coils of any desired length and in all regular widths and thicknesses.

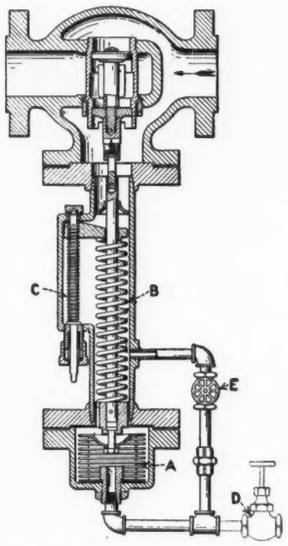
Oil-Level Control for Machine Bearings

TO PROVIDE a convenient means of supplying oil to bearings of inclosed motors or other bearings more or less inaccessible, the Duan-Walter Company, Milwaukee, Wis., has introduced the oil-level

Control unit complete with gage glass and bracket

control illustrated. The device, consisting of a reservoir with gage to show height of oil and supporting bracket, is mounted on the machine or at some convenient point adjacent thereto. From the bottom of the reservoir a pipe is led to each of the bearings in which the level is to be controlled.

The oil may be piped in any horizontal direction and can feed one or several bearings on the same level. Used in connection with special adjustable wick units, single or multiple bearings on different levels can be fed. Reservoir capacities range from ½ pint to 2 gallons.



Sectional view of governor

Governor for Turbine-Driven Feed Pumps

DESIGNED primarily for use with turbine-driven feed pumps, the style R feed pump governor, illustrated, now being put out by the Bailey Meter Company, Cleveland, Ohio, embodies the important feature of the excess-pressure regulator described in the March 4, 1930, number. In the new governor a high-pressure sylphon instead of a piston is used to operate the valve.

Feed-water pressure is transmitted to the inside of the sylphon *A*, this force being balanced by the steam pressure and the spring *B* on the outside of the sylphon. When the steam pressure decreases, the sylphon expands, moving the valve mechanism upward, thus throttling the supply of steam to the turbine. In a similar manner more steam is admitted to the turbine when the steam pressure rises.

The governor may be set for any desired differential by adjusting the spring tension by means of screw *C*. To bypass the governor, valve *D* is closed and valve *E* is opened, thus equalizing the pressure on the inside and outside of the sylphon so that the spring will hold the valve in its open position.

The valve is of tight-seating, fully balanced design, and the entire seating arrangement can be easily installed or removed from the valve body without taking the latter from the line.

Portable Testing Kit

A NEW portable testing kit for alternating-current, for checking current and voltage in industrial plants and for central station use, has been announced by the General Electric Company, Schenectady, N. Y. The kit is designed to obviate the need of disconnecting leads or opening the circuit under test.

It includes a new split-core current transformer, a companion ammeter, another portable instrument, a 10-ft. two-circuit lead, and a leather carrying case. The transformer, ammeter and lead form a unit, and are calibrated together.

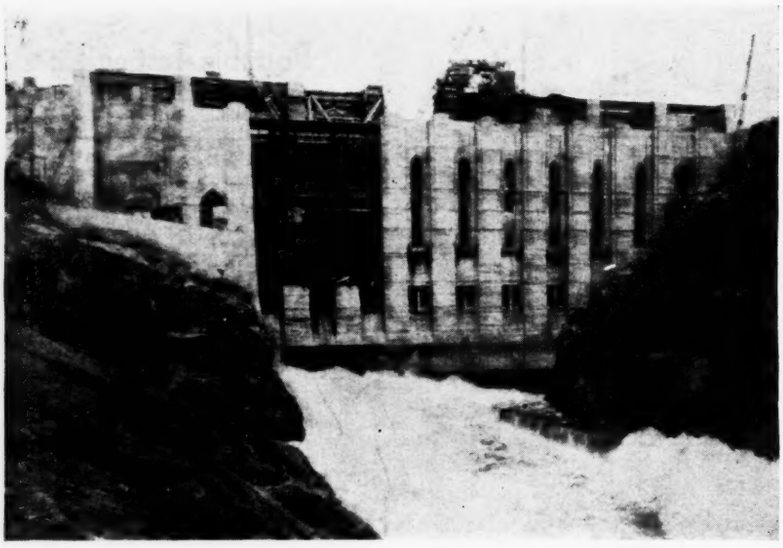
Opening with a flick of the thumb, the transformer snaps tightly closed, encircling the line wire. An ammeter, of the AS-3 type, is normally supplied but other instruments of the same type, single- and double-rated ammeters and single-, double- and triple-rated voltmeters, are available.

By using one turn of the line through the transformer, the ammeter indicates directly on the scale the actual current in the line. When it is desired to measure current lower than could normally be read directly on the scale, there are two turns through the transformer. The ammeter then indicates double the current in the line. This method can be carried further by increasing the number of turns through the transformer, and obtaining the actual current by dividing the reading by the number of turns.

Portable testing kit for checking current and voltage

NEWS of the FIELD

308,000-Hp. Hydro-Electric Development at Chute-a-Caron Rapidly Nears Completion



Looking upstream toward the power house of the Chute-a-Caron project, the tailrace is shown being used temporarily as a diversion channel

ONE OF THE LARGEST hydro-electric plants in Canada, that of the Alcoa Power Company at Chute-a-Caron on the Saguenay River, in the province of Quebec, is rapidly nearing completion. Two of the waterwheel generating units have been installed and two more are in process of installation. Normally rated at 65,000 hp. each, it is stated that these hydraulic turbines, among the largest in the world, will be capable of producing 77,000 hp. each or a total for the four units of 308,000 horsepower.

An interesting fact is that the Chute-a-Caron installation was provided to take care of the electrical power requirements of a single metallurgical industry set up in the nearby town of Arvida where the Aluminum Company of Canada requires huge quantities of electricity for reduction in electric furnaces of bauxite ores to alumina and for the subsequent production of aluminum by an electrolytic process.

The present Chute-a-Caron development marks the completion of the first stage in a two-stage development of the water power of the Saguenay River at this point. Ultimately it is planned to produce in the neighborhood of 1,000,000 hp., when the contemplated Shipshaw plant shall have been erected at a point two miles from the present dam.

In the meantime four large generators will go into operation, machines which are said to be remarkably compact. The outside diameter of each is 31 ft. and the overall height is 32 ft., while the total weight of each is approximately 1,200,000 lb. The generators were manufactured in Canada by the Canadian Westinghouse Company at Hamilton, Ontario, and in assembling them it is stated that 450,000 pieces were put into each machine.

A.S.M.E. to Hold Lubrication Meeting at Penn State, May 22

A ONE-DAY MEETING devoted to the subject of lubrication will be held on May 22 at Pennsylvania State College by the lubrication engineering committee of the American Society of Mechanical Engineers' Petroleum Division.

The program will consist of a morning session on lubrication research and an afternoon session at which, the chairman of the lubrication engineering committee, W. F. Parish, announces a symposium on internal-combustion-engine lubrication. The speakers at this session will be C. M. Larson of the Sinclair Refining Company who will discuss "Pennsylvania Oils," E. R. Lederer, vice-president of the Texas Pacific Oil & Coal Company, who will talk on "Midcontinent Oils," and A. L. Clayden of the Sun Oil Company whose subject will be "Coastal Oils."

There will be an informal dinner in the evening and also an opportunity to inspect machines and apparatus in the lubrication laboratory of the college.

Order 25,000-Kw. Steam Unit for Pasadena Plant

CONTRACT for the purchase of a 25,000-kw. steam turbine for the addition now under construction at the Pasadena, Calif., municipal light and power department plant on Glenarm Street, has been awarded the Allis-Chalmers Company, by the Pasadena city board of directors. The amount of the bid was $397,900. Benjamin F. DeLanty, general manager of the light and power department, announced that the bid includes an oil filteration system, a second auxiliary pump and a second air cooler and valve gear.

Completion of the addition will increase the capacity of the plant to 60,000 kw., and will increase the number of operating units to eight. Plans of the city now contemplate operation of the new unit either in March of next year or by the middle of next summer.

A.I.E.E. to Meet in Rochester, April 29-May 2

THE SEVENTH MEETING of the North Eastern District of the American Institute of Electrical Engineers will be held in Rochester, N. Y., from April 29 to May 2, with headquarters at the Sagamore Hotel. An interesting program has been arranged, consisting of four technical sessions, several inspection trips and special entertainment.

A feature of the technical sessions will be a symposium on noise, at which the following papers will be presented: "The Measurement of Noise in Electrical Machinery," B. F. Bailey; "An Indicating Meter for the Measurement and Analysis of Noise," T. G. Castner, E. Dietze, R. S. Tucker and G. T. Stanton; "The Measurement of Machinery Noise," H. B. Marvin; "Induction Regulator Noise," J. P. Foltz and W. B. Shirk; "Magnetic Noise in Synchronous

Machines," Q. Graham, P. Milliken and S. Beckwith; "Elastic Supports for Isolating Rotating Machinery," E. H. Hull and W. C. Stewart; "Noise Mitigation in Substations," E. A. Bishop. The symposium will be followed by a dinner meeting of the National Noise Study Committees, representing the N.E.L.A., A.S.M.E., A.I.E.E., N.E.M.A., and other organizations.

Other papers to be given at the meeting include "Losses in Transformers for Use With Mercury-Arc Rectifiers," E. V. DeBlieux; "Cusps in the Speed-Torque Curves of Induction Motors Due to Space Harmonics," P. H. Trickey; and seven papers on lightning investigations in the symposium to be held on lightning.

Plan 270,000-Hp. Water-Power Project in Sweden

EXCAVATION for what will be Sweden's largest power station will be started soon at Krangede Falls on the Indal River, near the Hammarforsen power plant, described in *Power* for Aug. 5, 1930.

To start with two vertical shaft units will be installed, each turbine developing 45,000 hp. on a head of about 190 ft., corresponding to 30,000 kw. per unit. It is ultimately intended to install six units, making a total of 270,000 turbine horsepower. The first installation is expected to be placed in service by 1935, and the turbines will be the largest in Sweden as regards capacity.

The power station will be built in the rock some 170 ft. below the surface, and the tail race tunnels to each unit will each be about 8,000 ft. long. It is calculated that 100 tons dynamite will be required for the blasting necessary for this installation.

Energy will be transmitted from the station southwards at 200,000 volts, which will be the first time this high voltage has been used in Sweden.

The owners of this new plant will be the City of Stockholm, three large iron and steel works—Fagersta, Sandviken, and Hofors—and the Bergslagens Gemensamma Kraftforvaltning, which is now distributing power in a large district in the middle of Sweden.

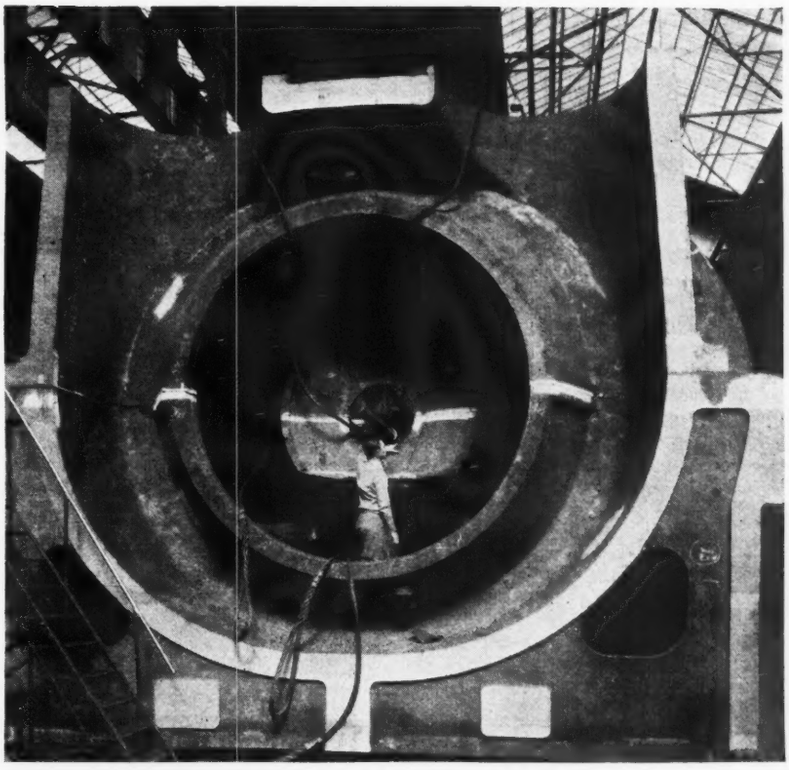
U. S. Chamber to Discuss Business Stabilization

POSSIBILITIES of business stabilization will be appraised at the nineteenth annual meeting of the Chamber of Commerce of the United States at Atlantic City, N. J., April 28 to May 1. The meeting, which will bring together business executives from all parts of the country, will give attention to important problems growing out of the business depression. These include the effects of government competition upon business, effects of anti-trust laws, the business cycle, industrial stabilization, and other questions of present interest to the business world.

One entire session of the conference will be devoted to a discussion of business stabilization, at which Dr. Wesley Mitchell, of Columbia University, one of the foremost economic authorities on the business cycle, will analyze and define stabilization. R. R. Deupree, president of Procter & Gamble, will explain the successful methods used by his concern in reducing seasonal fluctuations and maintaining employment on a reasonably constant level. L. D. H. Weld, an authority on distribution, will present marketing aspects, and Rome C. Stephenson, president of the American Bankers Association, will discuss the general aspects of stabilization from the financial viewpoint.

Whether the anti-trust statutes constitute a bar to business development will be considered at another session, together with the related question of governmental efforts to direct and control economic activities by assuming economic functions in direct competition with private enterprise. The practicability of developing a system of insurance, to soften the blow of industrial changes which cannot be foreseen or lie beyond the control of business management will also be discussed.

EXHAUST HOOD FOR 160,000-KW. UNIT



These giant castings, weighing approximately 115 tons—among the largest of their type ever produced, form half of the exhaust hood of one of two 160,000-kw. steam turbine-generators which are being manufactured in the Schenectady works of the General Electric Company for the Brooklyn Edison Company. The upper casting weighs approximately 45 tons, the lower one approximately 70 tons. The entire exhaust hood weighs approximately 230 tons

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Portland, Ore., Orders Extensive Power Survey

EXECUTION of the contract between the city of Portland and the engineering firm, Carey & Harlan, for an investigation as to the feasibility of municipal power development for the city was completed recently. The council had previously passed by a vote of three to two an ordinance appropriating $25,000 for this investigation, and calling for a contract to be made with this firm.

The contract sets forth seven specific provisions to be fulfilled by the report of the engineering firm. These include: (1) a study of all conditions affecting the cost of power at Umatilla Rapids on the Columbia River and delivery of this power to the city limits up to and including the receiving substation; (2) a study and estimate of the cost of developing other sites on the Columbia River including transmission giving the advantages and objections of each; (3) a similar study of generating and transmission costs of various sites on the Deschutes River on which the city of Portland has recently made filings; (4) to investigate fully the offer of the Columbia Valley Power Company and to make comparisons of what rates

could be charged under this offer with existing rates in the city as charged by the private companies; (5) to make a study of the privately owned electric power systems serving the city with reference to possible acquisition of either of these systems in whole or in part giving consideration to severance damages if only a part is to be required; (6) to correlate all the information secured in the studies of Nos. 1 to 5 above and to make a definite recommendation of the most feasible project with the estimated cost of such project and the possible rates that might be charged in the event the city should carry out such project; (7) to make a study of conditions affecting the sale of power in the vicinity of Portland and also to make an estimate of the probable cost of complete preliminary engineering including borings, foundations, water supply, and other items.

Pipe Ordered for Long Beach Natural Gas Line

AN ORDER for 76 miles of steel pipe amounting to $1,500,000 for a part of the natural gas pipe line from Kettleman Hills to Long Beach, Calif., was awarded the Western Pipe & Steel Company of California by the Southern Fuel Company, newly formed organization controlled by the Southern California Gas Company and Southern California Edison Company, Ltd. The contract for the 26-in. diameter pipe calls for fabrication by the automatic electric welding process. The order will require 15,000 tons of steel plates.

The 210-mile steel pipe line is being constructed to transport natural gas from Kettleman Hills to Long Beach for a fuel supply for the Long Beach steam generating plant for the Edison company. Some of the gas will be marketed for domestic, industrial, and commercial uses to consumers in Southern California. According to the present schedule planned, the line is to be put into operation by Nov. 1 of this year.

Order Compressors for Hoover Dam Construction

SIX COMPANIES, INC., the contractors who will build Hoover Dam, have placed orders with Ingersoll-Rand Company for all air-compressor and rock-drilling equipment that will be required for this record breaking five-year project. The stationary air plant will consist of a battery of large electric-driven compressors having a combined output of 25,000 cu.ft. per minute.

These compressors will supply air for driving the four diversion tunnels that will carry the waters of the Colorado River through the canyon walls around the damsite while the dam proper is being built. Work will start immediately upon these tunnels and it is expected they will be finished within 18 months.

COMING CONVENTIONS

American Society of Mechanical Engineers. Lubrication meeting at Pennsylvania State College, May 22. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Spring meeting at the Athletic Club, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

MARCEL GARSAUD and CLAUDE L. DRAPER, members of the Federal Power Commission; Col. MAX TYLER, the commission's chief engineer; and WILLIAM V. KING, its chief accountant, arrived in Buffalo, N. Y., last week with a staff of engineers and accountants to begin work on determining the fair value of the properties of the Niagara Falls group of power companies, in accordance with the agreement reached on March 17 between the commission and the Niagara Hudson Power Corporation. The engineering phase of the investigation will be under the direction of FRANKLIN D. NASH, who has had long experience in railroad valuation.

L. B. STILLWELL, consulting engineer of New York, will be named chairman of the special committee on power at the meeting of the American Engineering Council administrative board, to be held in Washington, D. C., on May 15 and 16. Other members of the committee will be CHARLES BROSSMAN, consulting engineer of Indianapolis; A. J. HAMMOND, consulting engineer of Chicago; J. P. HOGAN, of Parsons, Klapp, Brinckerhoff & Douglass; J. C. HOYT, hydraulic engineer of the United States Geological Survey; JOHN H. LAWRENCE, president of Thomas E. Murray, Inc.; I. E. MOULTROP, chief engineer of the Edison Electric Illuminating Company of Boston; and E. N. TRUMP, mechanical engineer of Syracuse.

B. W. CREIM, electrical engineer of the Modesto Irrigation District, has been elected president of the newly formed Publicly Owned Gas & Electric Utility Association of California, the purpose of which is to promote the interests and welfare of publicly owned gas and electric utilities in the state. Other officers elected are: first vice-president, PETER DIEDERICH, superintendent of plant and production, Glendale; second vice-president, F. R. CHILTON, city clerk, Roseville; and secretary-treasurer, J. H. MCCAMBRIDGE, general superintendent, Public Service Department, Burbank.

M. C. SMITH has been named manager of the El Paso Electric Company, succeeding FRANCIS J. GANNON, who was transferred to Tampa, Fla., where he will be vice-president and manager of the Tampa Electric Company, and its subsidiaries. Mr. Smith for the past six years has been president of the Baton Rouge Electric Company and was also president of the Louisiana Steam Products Company.

E. K. LANNING, of the Warren Webster Company, was re-elected president of the Steam Heating Equipment Manufacturers' Association, at the association's annual meeting held in Chicago recently. Other officers elected were: vice-president, J. C. MATCHETT, Illinois Engineering Company; treasurer, W. E. BARNES, Barnes & Jones; and secretary, E. J. RITCHIE, Sarco Company.

Business Notes

RILEY STOKER CORPORATION, Worcester, Mass., and the BADENHAUSEN CORPORATION, Cornwells Heights, Pa., announce that a consolidation of the two corporations has been effected. This consolidation places the Riley company in a position to furnish its fuel-burning equipment and Badenhausen steam-generating units under a single contract without division of responsibility, it is stated.

NEILAN COMPANY, Los Angeles, Calif., announces the appointment of William T. Mayer as manager of its San Francisco office. It is also announced that O. H. Seal has been added to the staff of the company's New York office.

DENVER FIRE CLAY COMPANY, Denver, Colo., announces the appointment of the Peden Company, Houston, Texas, as distributor of its products in that territory. A similar appointment has been made to the E. L. Wilson Hardware Company, Beaumont, Texas, it is stated.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has promoted L. M. Dunning to sales representative of the Chicago office, and Herbert A. Holmes to sales representative of the Pittsburgh office.

WILLIAM POWELL COMPANY, Cincinnati, Ohio, announces the appointment of Oliver F. Gang as assistant sales manager.

JONES & LAUGHLIN STEEL CORPORATION, Pittsburgh, Pa., announces the purchase of the Lukens Steel Company's plant at New Orleans, La. Acquisition of this plant, it is stated, will give Jones & Laughlin a large, modern steel fabricating, warehousing, and distributing base at the mouth of the Mississippi.

SHAW-KENDALL ENGINEERING COMPANY, Toledo, Ohio, announces the purchase of the TERRE HAUTE NIPPLE MANUFACTURING COMPANY of Terre Haute, Ind. The Terre Haute plant has been moved to Toledo and pipe nipples are now being manufactured at that point, in addition to the other products of the Shaw-Kendall company. Louis Plost will continue in charge of sales under the new set-up and there will be no change in the policy formerly pursued by the Terre Haute organization.

THE HAYS CORPORATION, Michigan City, Ind., recently held a benefit "housewarming" for the new addition to its factory, which will house the brass and aluminum foundry departments of the company. Proceeds of the affair, amounting to $107.75, were donated to the local unemployment relief fund.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the removal of its Chicago office from 53 West Jackson Blvd. to larger quarters at 1455 West 37th Street.

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WITH THE SOCIETY SECTIONS

A.S.M.E., Baltimore Section. Joint meeting with the Baltimore Sections of the A.I.E.E. and A.S.C.E. and the Baltimore Engineers Club at the Pennsylvania Water & Power Company, Holtwood, Pa., on April 23. Subjects: "Holtwood Hydraulic Laboratory and Its Contribution to the Design of the Safe Harbor Development," by G. W. Spaulding, Pennsylvania Water & Power Company; "Construction of the Safe Harbor Development," by C. W. Black, The Arundel Corporation.

A.S.M.E., Metropolitan Section. Meeting in the Engineering Societies Building on April 29 at 8 p.m. Subject: "Developments of the Stationary Diesel Engine Under the Conditions of American Power Economics," by Julius Kuttner, editor of *Diesel Power*.

A.S.M.E., New Haven Section. Meeting at Mason Laboratory, Yale University, on April 24 at 8 p.m. Subject: "Internal Combustion Engines," by Professor L. C. Lichty, Yale University.

A.S.R.E., Boston Section. Dinner meeting at the Chamber of Commerce on April 23 at 6:30 p.m. Subject: "Symposium on Low-Temperature Insulants," by representatives of various low-temperature insulation companies.

Providence Engineering Society. Meeting in the society rooms on April 28 at 8 p.m. Subject: "Developments in Heating, Air Conditioning and Piping," A. W. Moulder, Grinnell Company.

Princeton University. Lecture at the Green School of Engineering on April 23 at 8:30 p.m. Subject: "Theoretical Hydrodynamics and Hydraulics," Dr. Theodor von Karman, Technical University of Aachen, Germany.

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Trade Catalogs

POWER-PLANT EQUIPMENT—The Elliott Company, Jeannette, Pa., has recently issued a 24-page illustrated bulletin, No. Q-2, covering its entire line of power-plant equipment, which includes turbine- and engine-generators, motors and motor-generators, centrifugal blowers, condensers, ejecters, deaerators, feed-water heaters, desuperheaters, strainers and accessories, and the tube cleaners manufactured by its associates, Liberty Manufacturing Company and Lagonda Manufacturing Company. The Elliott Company has also issued Bulletin H-6, describing and illustrating a new single-stage, mechanical-drive steam turbine built in a size range from 5 to 60 horsepower.

INSTRUMENTS — James G. Biddle, 1211-13 Arch St., Philadelphia, Pa., has recently issued the following new bulletins: No. 1270 on vibrating-reed frequency meters, No. 1275 on speed-measuring instruments, No. 1280-S on a 1,000-volt insulation tester, and No. 1280-P on "Pointolite" lamps.

AMMETERS—Bulletin No. 374 of the Bristol Company, Waterbury, Conn., illustrates and describes the company's "Triplex" recording ammeters.

STEAM METERS—Builders Iron Foundry, Providence, R. I., has recently issued Bulletin 255 covering in detail its shunt meter for steam, air, and gas measurement. This bulletin features the new expanded capacity tables showing standard orifice sizes for both steam and air meters.

FLEXIBLE COUPLING—The Rawson automatic starter and flexible coupling for use with standard motors is illustrated and described in Bulletin 107 recently issued by The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass.

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Fuel Prices

FUEL OIL

Boston—April 13, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.9c. per gal.

New York—April 16, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—April 8, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—April 8, f.o.b. local refinery, fuel oil, 36@40 deg., 2.875c.@3c. per gal.

Cincinnati — April 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—April 8, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 50c. per bbl.; 22@24 deg., 55c. per bbl.; 24@26 deg., 60c. per bbl.; 26@28 deg., 70c. per bbl.; 28@30 deg., 80c. per bbl.

St. Louis—April 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.295 per bbl., or 42 gal.; 26@28 deg., $1.395 per bbl.; 28@30 deg., $1.495 per bbl.; 30@32 deg., $1.595 per bbl.; 32@36 deg., gas oil, 3.276c. per gal.; 38@40 deg., distillate, 4.026c. per gal.

Dallas—April 11, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol..	New York...	$1.90 @$2.25
Pool 10, h. gr. low-vol.	New York...	1.75 @ 1.85
Pool 11, low-vol.....	New York...	1.60 @ 1.75
Smokeless, mine-run..	Chicago.....	1.50 @ 2.00
Smokeless, slack.....	Chicago.....	1.25 @ 1.35
Harlan, Ky., slack....	Chicago.....	1.00 @ 1.10
Franklin, Ill., mine-run	Chicago.....	2.15
Franklin, Ill., screen...	Chicago.....	1.65 @ 1.75
Ind. 5th Vein, m.-r....	Chicago.....	1.20 @ 1.75
Standard Ill., mine-run	St. Louis....	1.50
W. Ky., mine-run	Louisville....	.90 @ 1.25
W. Ky., slack.....	Louisville....	.70 @ .85
Pittsburgh, mine-run.	Pittsburgh....	1.35 @ 1.45
Smokeless, mine-run..	Cincinnati...	1.75 @ 2.00
Smokeless, slack.....	Cincinnati...	1.00 @ 1.30
Kanawha, mine-run..	Cincinnati...	1.10 @ 1.35
Kanawha, nut-slack.	Cincinnati...	.85 @ 1.25

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York...	$3.25
Barley.....	New York...	1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Mammoth Springs — Arkansas-Missouri Power Co., 72 West Adams St., Chicago, Ill. and C. V. Sebaugh, Blytheville, Ark., Dist. Mgr., having preliminary plans prepared for the construction of two power dams on Spring River, one about a mile below Mammoth Springs and the other five miles farther down stream to generate 650 and 2,550 hp. Estimated cost $320,000. Private plans.

Calif., Burlingame—City is having plans prepared for the construction of a sewage disposal plant and pumping station. Estimated cost to exceed $25,000. C. M. Thomas is city engineer.

Calif., Los Angeles—General Investment Corp., is having plans prepared for the construction of a 13 story apartment building including steam heating system, etc. at Curson Ave. between Sixth and Wilshire Blvd. Estimated cost $1,000,000. G. Verge, 802 Beaux Arts Bldg., is architect.

Calif., Pasadena—City awarded contract for a 25,000 kw. steam turbine for addition to municipal power plant now under construction to Allis-Chalmers Co., 458 South Spring St., Los Angeles, $397,900.

Calif., San Francisco—Anchor Chain Co., 11 Stuart St., plans the construction of a 22 story office building at Market and Stuart Sts. Estimated cost $2,000,000. H. H. Winner, 580 Market St., is architect.

Calif., Watsonville—Union Ice Co., 354 Pine St., San Francisco, awarded contract for the construction of an ice manufacturing plant here to W. W. Williamson, 320 Market St., San Francisco. Estimated cost $100,000.

Colo., Grand Junction — City Council, defeated $750,000 bond election for the construction of a power plant. Wood & Weber, 810 14th St., Denver, are engineers.

D. C., Washington—Treasury Dept., Office of the Supervising Archt., will receive bids until April 22, for extension to and remodeling of power house for Dept. of Agriculture.

Ind., Bloomington—City is having plans prepared for the construction of a pumping station at Griffy and Bean Blossom Creeks in connection with waterworks. Estimated cost $15,000. Pearce, Greeley & Hansen, 6 North Michigan Blvd., Chicago, Ill., are engineers.

Ind., Lafayette—Purdue University, will receive bids until May 5, for addition to heating and power plant. Estimated cost $100,000. W. Scholer, 201 Wallace Bldg., Lafayette, is engineer. Owner will purchase boilers and power plant equipment.

Ia., Harper — Continental Construction Co., c/o H. L. Doherty & Co., 208 South La Salle St., Chicago, Ill., awarded contract for an 88 x 146 ft. compressor station, 40 x 122 ft. auxiliary building, storage warehouse, etc., also laying pipe line of various sizes and unloading and placing of station equipment here to Lanning Construction Co., Newton, Ia. Estimated cost $200,000.

Ia., Waterloo—Crystal Ice & Fuel Co., 129 East Mullan Ave., awarded contract for the construction of an 80 x 120 ft. ice manufacturing plant to H. A. Maine Construction Co., 305 Marsh Place Bldg. Estimated cost $75,000. Equipment contract let to Vilter Mfg. Co., 2217 South First St., Milwaukee, Wis.

La., Baton Rouge—Stone & Webster Corp., 818 Olive St., St. Louis, Mo., will build additional unit to Louisiana Steam Products Plant here. Estimated cost $750,000 including equipment. Contract awarded for boilers.

Mass., Barnstable—Cape Cod Gas Co., Hyannis, awarded contract for the construction of an illuminating gas plant here to J. H. Burke, 221 High St., Wareham. Estimated cost $40,000.

Mass., Boylston — Worcester County, W. Goodale, Chn. of Bd. of Comrs., Court House, plans the construction of a tuberculosis hospital on Kendall Farm. Estimated cost $1,000,000. Frost, Chamberlain & Edwards, 390 Main St., Worcester, are architects.

Mass., Springfield — Commanding Officer, Springfield Armory, will receive bids until April 28 (extended date) for replacement of steam boiler plant at Hill Shops, Springfield Armory.

Minn., Cambridge — State Bd. of Control, Capitol, St. Paul, plans power plant additions at School for Epileptics here. $161,000.

Mo., Caruthersville—W. A. Howard and S. J. Campbell, Kansas City, have been granted franchise and will construct a plant for vaporization of butane gas, also distribution mains throughout city. Private plans.

Neb., Alliance—Dept. of Municipal Utilities, C. H. Rockey, Supt., plans 21 miles of rural lines with transformer equipment. Work will be done by owner's forces.

Nev., Reno—Southern Pacific R.R., 65 Market St., San Francisco, is receiving bids for the construction of a 40 x 268 ft. freight shed with 380 x 16 ft. loading platform, etc. here. G. W. Boschke, San Francisco, is chief engineer.

N. J., Convent Station—St. Elizabeth's College, Sisters of Charity, will soon award contract for the construction of a 68 x 95 ft. power house. Estimated cost $40,000. Fanning & Shaw, 47 Ward St., Paterson, are engineers.

N. J., Elizabeth—Bd. of Commissioners, City Hall ,plans the construction of a city hall and municipal building, including steam heating system, etc. Estimated cost $1,000,000. Oakley & Son, 1259 Clinton Pl., are architects.

N. Y., Brooklyn—Dept. of Hospitals, Municipal Bldg., New York, had plans prepared for the construction of a power generating plant at Kings County Hospital, Clarkson and Albany Aves. here. Estimated cost $800,000. L. P. Ward, 205 East 42nd St., New York, is engineer.

O., Cleveland—John Carroll University, J. J. Bernet, Chn. of Bldg. Comm., West 30th St. and Carroll Ave., awarded contract for administration building, dormitory buildings, service building, etc., including steam heating system on Washington Blvd. to Hunkin-Conkey Construction Co., Newman-Stern Bldg. Estimated cost $2,500,000.

O., Cleveland—Spencerian School, E. E. Merville, Pres., 3201 Euclid Ave., plans the construction of a central heating plant. Estimated cost $40,000. Engineer not selected.

O., East Cleveland—Huron Road Hospital, S. Reynolds, Supt., 8811 Euclid Ave., Cleveland, awarded contract for a 6 story hospital and service building at Belmore and Euclid Ave. to J. Gill & Sons, Bulkley Bldg., Cleveland. Estimated cost $1,000,000. Steam heating system, etc. will be installed.

Pa., Pittsburgh—Governor Investment Co., J. K. Tenor, Pres., c/o Richard Hartje, Webster Hall, will receive bids about June 15 for the construction of a 34 story hotel at 10th and Liberty Sts. Estimated cost $4,000,000. Simons, Brittain & English, 814 Magee Bldg., are architects.

Texas—Louisiana—Arkansas Natural Gas Co., c/o Cities Service Co., 60 Wall St., New York, N. Y., awarded contract for the construction of a gas pipe line from near Longview, Tex. to Shreveport, La., including pumping stations, etc., to Ford, Bacon & Davis, 39 Broadway, New York.

Tex., Beaumont—City plans an election in the fall to vote $1,000,000 bonds for waterworks improvements including distribution system, pumping unit, etc. R. C. Black, City Hall, is city engineer.

Tex., Eagle Pass—Central Power & Light Co., National Bank of Commerce Bldg., San Antonio, plans the construction of a power plant building for light and power unit here. J. Marriott, National Bank of Commerce Bldg., San Antonio, engr.

Tex., Port Aransas — Grail-Borden-Munson Co., awarded contract for the construction of an oil loading dock, 402 ft. long and 30 ft. wide, to W. Richardson, Slidell, La. Estimated total cost $200,000.

Utah, Salt Lake City—U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until April 30 for the construction of a group of buildings including refrigerating and ice making plant, boilers and boiler plant equipment, etc., at U. S. Veterans Hospital here.

Va., Martinsville—Martinsville Gas Co., N. H. Gelbert, Meadowbrook, Pa., Pres., recently organized to generate, manufacture, distribute and sell natural, manufactured or mixed gas. Plans the construction of a plant also 15 mi. of pipe line in Henry Co.

Alta., Turner Valley — Hercules Consolidated Mining & Smelting Co. Ltd., London, England, plans development of waste gas into one pipe line using pressure of gas to turn specially designed turbine wheels in the manufacture of electrical energy here. Initial cost $10,000,000.

Equipment Wanted

Engines, Boilers, etc.—Mare Island and San Diego, Calif.—Bureau of Yards & Docks, Navy Dept., will receive bids until April 29 for two 25 ton floating steel derricks with steam engines and oil burning boilers, one at Mare Island and one at San Diego.

Pump—Glendale, Calif.—City Council, is receiving bids for a 2,000 g.p.m. horizontal centrifugal pump, 320 ft. head; 2,600 g.p.m. horizontal centrifugal pump, 260 ft head direct connected to 50 cycle motor and automatic starter and control equipment for proposed waterworks.

Pump and Motor—Ventura, Calif.—County Supervisors will receive bids until May 5 for furnishing and installing motor driven deep well turbine pump and motor for proposed waterworks.

Pumping Equipment — Falmouth, Mass. — Water Commissioners, Town Hall, will receive bids until April 30 for furnishing and installing equipment in pump house.

Pmps and Equipment—St. Joseph, Mich.—City plans to purchase motor driven centrifugal pumps and equipment for pumping station and filtration plant of city waterworks. Estimated cost $175,000.

Pumps and Motors — Audubon, Ia. — City plans to purchase 125 g.p.m. pumping units, four 5 hp. and two 50 hp. motors, etc., in connection with waterworks. $40,000.

Regulators, etc.—Wellington, N. Z.—Dept. of Public Works, will receive bids until May 19, for 2,250 extra high tension suspension strings complete with fittings for Aropuno power plant, also until June 2, for two outdoor type automatic induction voltage regulators for Lake Coleridge power plant.

Industrial Projects

Conn., Newington—Keeney Mfg. Co., Main St., awarded contract for a 1 story, 45 x 120 ft. addition to factory on Main St. to R. G. Bent Co. Inc., 93 Edwards St., Hartford. Estimated cost $40,000 including equipment.

Md., Baltimore—Campbell Metal Window Co., Bush and Hamburg Sts., awarded contract for the construction of two factory buildings, 1 story, 24 x 200 ft. and 2 story, 80 x 100 ft. to Davis Construction Co., 9 West Chase St.

Mass., Peabody—Carr Leather Co., 111 Foster St., is receiving bids for the construction of a 5 story, 45 x 100 ft. leather factory. Estimated cost to exceed $40,000. Private plans.

N. J., Butler—American Hard Rubber Co., Boonton Ave., plans addition to rubber plant. Estimated cost $40,000. Private plans.

N. J., Newark—A. Gross & Co., Doremus Ave., awarded contract for the construction of a 1 story, 85 x 100 ft. candle manufacturing plant at 652-70 Doremus Ave. to E. M. Waldron Inc., 40 Park Pl. Estimated $40,000.

O., Alliance—Machine Steel Castings Co., W. E. Trump, Gen. Mgr., will soon receive bids for the construction of a 1 story, 40 x 100 ft. factory, also addition to core room and installation of conveyor system and new moulding machines. Estimated cst $55,000. Private plans.

O., Cleveland—American Multigraph Co., H. C. Osborn, Pres., 1814 East 40th St., plans the construction of a factory. Estimated cost $50,000. Architect not selected.

Pa., Conshohocken — Reilly Whitman & Walton Co., Canal Bank Bldg., awarded contract for the construction of a 1 and 2 story, 122 x 144 ft. oil plant to E. A. Reeves, 107 York Rd., Abington.

Pa., Philadelphia—Barrett & Co., 40 Rector St., New York, N. Y., awarded contract for the construction of a group of buildings for coal tar products plant to Turner Construction Co., Architects Bldg. Estimated cost $150,000.

Tex., El Paso—Nichols Copper Co., 25 Broad St., New York, N. Y., c/o J. P. Dwyer, Mgr., P. O. Box 1372, El Paso, plans the construction of a rod mill and copper wire factory here. Estimated cost $1,500,000.

Alta., Calgary—Provincial Government, Edmonton, plans the construction of a semi-commercial plant for the manufacture of benzine from waste gas here. D. E. H. Boomer in charge.

Ont., Brockville—Eugene F. Phillips Electrical Works, Kingston Rd., awarded contract for the construction of a copper rod rolling mill to Dominion Engineering Works Ltd., Lacine, Que. Estimated cost $225,000.

Ont., Hamilton — John Duff & Sons Ltd., Brant St., will soon award contract for the construction of a 2 story, 75 x 150 ft. packing plant on Hillyard St. Estimated cost $100,000. Stewart McPhie, Sun Life Bldg., is architect. Packing and refrigeration equipment will be required.